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Adaptive Role-Play Exercises for a Leader Development Center

Michael Hertz
Progeny Systems Corporation

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14. ABSTRACT *(Maximum 200 words)*:

This report describes work performed under a Phase I Small Business Innovation Research Contract. This report describes two research and development activities. One effort was the creation of a plan for the development of a Leader Development Center. Progeny Systems proposed to create a simulation or scenario-driven computer-based assessment of an individual's leadership performance. In order to create this computer-based assessment solution, the relevant literature had to be reviewed to develop the theoretical framework for the proof of concept solution. The other significant effort was the creation of a system to deliver content, capture user responses, and report results out to an external system. This Simulation Delivery System was created using XML, web services and the .Net 2.0 framework to minimize the client-side code and keep as much processing and functionality on the web server as possible. Moving the functionality out of the Simulation Environment also granted flexibility in which Simulation Engine could be used. These web services were further split into three different, but complementary functions, Get Leadership Data, Get Simulation Parameters, and Store Leadership Simulation Results.

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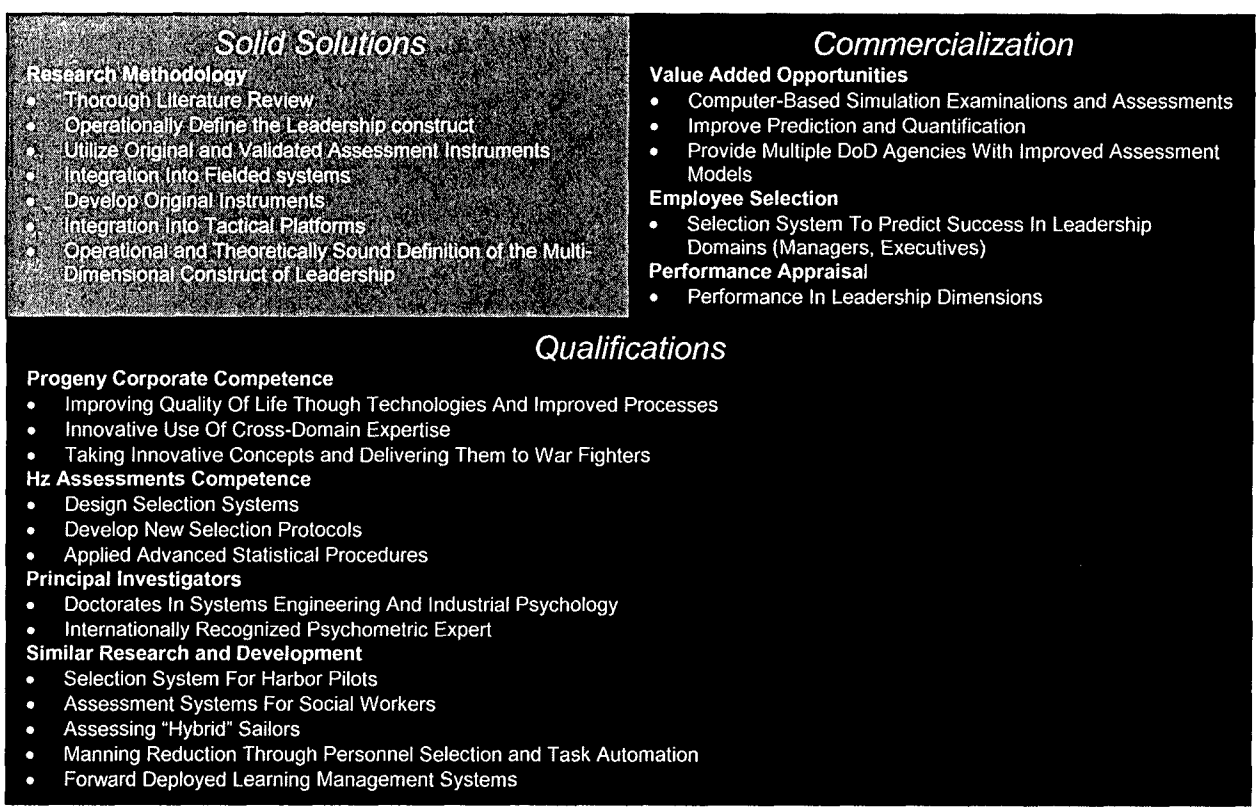
1 Executive Summary of the Phase I Effort Completed To-Date

The Phase I approach could be summarized by describing two independent but related research and development activities. One effort was the creation of a plan for the development of a Leadership Develop Center. In the Phase I proposal, Progeny Systems proposed to create a simulation or scenario driven computer-based assessment of an individual's leadership performance. In order to create this computer-based assessment solution the relevant literature had to be reviewed to develop the theoretical framework for the proof of concept solution. Progeny Systems reviewed literature on feedback interventions, naturalistic decision making, leadership behaviors and the leadership literature in general.

The other significant effort was the creation of a system to deliver content, capture user responses, and report the results out to an external system. This Simulation Delivery System was created using XML, web services and the .Net 2.0 framework to minimize the client-side code and keep as much processing and functionality on the web server as possible. Moving the functionality out of the Simulation Environment also granted flexibility in which Simulation Engine could be used. These web services were further split into three different, but complementary functions, Get Leadership Data, Get Simulation Parameters, and Store Leadership Simulation Results. A detailed description of the Phase I work is described in Section 3



2 Leadership Assessment Center

While the operating theater, the details of the conflict, and tactics of the enemy often change from engagement to engagement or even during the same conflict, the value of finding, assessing and retaining leaders is always a major task for the Army. Historically, it has been difficult for the Army to identify individuals with high leadership potential a priori to some critical event. In other words, the nature of a battlefield often leads to leaders being identified based upon their performance during the heat of the battle. However, waiting until a conflict arises is not the most

efficient or safest way for leaders to be identified. The effort described in this final report represents one method of developing a Leadership Assessment Center based upon both existing technologies and assessment batteries and the extension of technologies not normally associated with Leadership assessment. Through the continued development of the prototype completed for this Phase I and the extension on the relevant literature, Progeny Systems is confident that an end to end solution for a Leadership Assessment Center can be developed.

End-to-End Solution Requirements	Progeny Efforts That Support Vision
• Ability To Establish A Theoretical Foundation For the Leadership Construct.	• Progeny Systems and it's teammates have the technical and research skills necessary to identify the relevant academic and industrial literature to create a working, testable and extensible definition of the Leadership Construct
• Capitalize on Existing Assessment Techniques and Validated Assessment Batteries for Component Dimensions of the Leadership Construct	• Through the use of commercial Learning Management Systems, Progeny Systems already has the expertise necessary to combine existing multi-modal assessment techniques into a single seamless Leadership Assessment Center
• Ability To Move Data and Information From Central information warehouses to Distributed Locations	• In order to capitalize on the investment necessary to create and maintain different assessment instruments, Progeny Systems proposes to use its proven technology to manage the data, ensure its credibility / authenticity, deliver the content to the end user and finally report the results to the Army for integration into its personnel information systems.
• Ability to Develop A Software Based Leadership Assessment Centers	• Progeny Systems has developed portions of the software functionality within the Non-tactical Data Processing System (NTDPS) for the Navy and for many other programs for all branches of the Armed Services. Progeny Systems has the Psychometric expertise to build a Leadership Assessment Center that will provide the Army with unparallel ability to assess individuals on the Leadership Construct. Progeny Systems is totally committed to working with third party companies whose functionality, technology, or assessment batteries the Government wants integrated into the solution. Progeny Systems is a member of the NAVSEA Open Architecture/Open Source (OA) initiative as well as other industry standards and committed to their principles of open collaboration.
• Ability to Get the Solution To The Warfighter	• Progeny Systems has fielded The NTDPS application suite on VIRGINIA and 15 688 class submarines. Progeny Systems is supporting NSWC Crane in the fielding of Distance Support 1.0 on surface ships starting in the Summer of 2006. While Progeny Systems has yet to deliver a system to the Army, our proven track record with getting systems to warfighters in the Navy shows that we understand the issues facing the introduction of technology to the Armed Services

3 Simulation Delivery System Development

The primary goal of for this component of the Phase I effort was to develop a system for delivering customizable simulations to the Learner. The simulations needed to be aware of the Learner's existing skill set (i.e. education, training, relevant experience) as well as any parameters defined by the Training Administrator to either increase or decrease overall system complexity. Progeny Systems started this effort by defining the various Data Types that would be required for tracking the learners skill set and for defining "complexity" in terms of a leadership assessment center. Next, Progeny Systems defined and developed the Data Access methods to provide a standard interface between the Learner's data and the target Simulation Environment. Progeny Systems then developed the tools required to manipulate the stored Learner data. Some of which will be replaced by existing Army tools, or other commercial implementations in the Phase II effort. Finally, Progeny Systems designed and developed a prototype Simulation Engine to demonstrate the theoretical concepts and to verify and validate the logistics of the data movement, capture and storing processes.

3.1.1 Data Types

To ease the deployment requirements and provide greater flexibility, all of the Data Types are stored in XML. Associated schemas have also been created for validating the stored Data Types.

3.1.1.1 Leadership Training Records

Leadership Training Records (LTRs) are a subset of the Soldier's complete Electronic Training Jacket. LTRs represent a Learner's existing demonstrated Leadership Skills across all the identified dimensions of leadership in a manner similar to current Learner Management System's (LMS) learned skill format. (Progeny acknowledges that "LTRs" do not exist at this moment in a quantified form, but are being used for this prototype to facilitate development and simply the mechanics of transitioning from a proof of concept to a prototype. The effort needed to construct the data and measurement instruments for the LTR concept is described in more detail in the Phase II work plan.) This design approach was chosen to ease the process of integrating the LTRs into the existing Army LMS during the Phase II effort.

3.1.1.2 Simulation Adjustment Parameters

Simulation Adjustment Parameters (SAPs) were developed to provide a mechanism for Training Administrators to customize the simulation difficulty and other simulation specific parameters. SAPs are created on a per Simulation basis and contain details about all of the adjustable variables that the Simulation uses. Details on how to present the parameter to the Training Administrator are also stored in the SAP. The current implementation supports displaying Strings, Integers, Floats (Double), Boolean and Ranges. In the future any data type that can be parsed from a String can be utilized. Additionally, a detailed description about what each parameter controls is included to help the Training Administrator properly adjust the simulation complexity.

3.1.1.3 Individualized Simulation Adjustment Parameters

Individualized Simulation Adjustment Parameters (ISAPs) contain the adjusted parameter values for a specific combination of Simulation and Learner. The parameters stored in the ISAP are based off of the parameters defined in the associated Simulation's SAP (see section 3.1.1.2). In the current prototype implementation there can only be one ISAP associated per Learner and Simulation combination. The Training Administrator must redefine the parameters between each simulation attempt by the Learner if he/she wishes to adjust the difficulty.

3.1.1.4 Leadership Simulation Results

Leadership Simulation Results are expected to be generated by the Simulation Engine. They contain three main sections:

Assessment Scores

The Assessment Scores section contains the objective assessment results for the Leadership Skills or Behaviors measured in the Simulation. These results utilize the Leadership Training Records (see section 3.1.1.1) Leadership Skill format for easy parsing into the Learner's LTR.

Learner Activity Log

The Learner Activity Log is a record of actions taken by the Learner during the simulation. This record is intended to be used during Simulation Performance feedback interventions and debriefs.

Individualized Simulation Adjustment Parameters

The Leadership Simulation Results contain a copy of the ISAP values for reference purposes. This will allow the Training Administrator to see the effect of the various ISAP parameter values on the Learner's training performance.

3.1.1.5 Prototype Simulation Script

To showcase the Phase I innovations Progeny Systems needed to develop a basic Simulation Engine. Part of that development included developing a reusable format for defining the Simulation Events. Progeny Systems chose to implement a rudimentary Decision Tree similar to a "Choose your own ending" story. As the solution matures, a more complicated Bayesian approach could be utilized on the same framework as the currently implemented deterministic decision tree. Through the use of Bayesian probability theory, decisions can take a more varied approach with the added realism that the same decision every time through the system might not produce the same results. Just as in interacting with people, one technique might be appropriate one day, but then a different technique would need to be used on a second incident even through all the relevant characteristics of the situation appear to be the same. The Decision Tree consists of various Node types:

Forced Continue Node

A Forced Continue Node is used to progress the simulation story without presenting the learner with a decision. At the end of the node text the user is presented with a button that links them to the next Node in the story.

Conditional Redirect Node

A Conditional Redirect Node is used when the Simulation Author wants to introduce logic based branching into the simulation story. When the Simulation Engine encounters a Conditional Redirect Node it compares the value of the specified Conditional Variable to the available options and redirects to the specified Node upon a match. Linking several Conditional Redirect Nodes allows the Simulation Author to make very complex decisions with little or no programming skill.

Decision Node

The Decision Node type is the primary type of node used. It contains text for the simulation story, a question to the Learner about what action they wish to take and a list of available options. Each option contains a reference to the Node that should be loaded if it is chosen. Options may also modify simulation variable values when selected. Additionally, the presented options can be limited based on existing variable values. This ability is utilized when presenting more options to an experienced Learner and fewer options to the novice Learner.

3.1.2 Data Access Web Services

During the Phase I Simulation Engine evaluations Progeny Systems determined that Web Services could be utilized to deliver the Leadership Training Records and Simulation Adjustment Parameters to almost any Simulation Engine. By defining standard Data Access Web Services Progeny could remove the burden of getting and saving Leadership Skills from the Simulation Author. The Simulation Author would also be able to choose the Simulation Engine that best displayed their Simulation instead of being forced to use a standard Simulation Engine.

As part of the Prototype Simulation Engine development that Progeny Systems performed to showcase the Phase I innovations, Progeny Systems also developed the Prototype Get Simulation Web Service. This service is not expected to be used by other Simulation Engines.

3.1.2.1 Get Leadership Data

The Get Leadership Data web service provides a standard interface for retrieving a Learner's Leadership Training Records (see section 3.1.1.1). The Simulation Engine is expected to call the Get Leadership Data web service passing the Learner's Unique ID. If an LTR is found for the specified Learner the Get Leadership Data web service will return an XML formatted LTR. Otherwise, it will return an empty XML element. The Simulation Engine can then utilize the Learner Skills in whatever way the Simulation Author intended.

3.1.2.2 Get Simulation Parameters

The Get Simulation Parameters web service provides a standard interface for retrieving Individualized Simulation Adjustment Parameters (see section 3.1.1.2) for a given Simulation and Learner combination. The Simulation Engine is expected to call the Get Simulation Parameters web service passing the Learner's Unique ID and the Simulation's Unique ID. If an ISAP is found for the specified Learner and Simulation combination the Get Simulation Parameters web service will return an XML formatted ISAP. Otherwise, it will return an empty XML element. The Simulation Engine can easily utilize the parameters in the ISAP to set the default state of the Simulation Variables.

3.1.2.3 Store Leadership Simulation Results

The Store Leadership Simulation Results web service provides a standard interface for saving a Learner's Leadership Simulation Results (see section 3.1.1.4). The Simulation Engine is expected to call the Store Leadership Simulation Results web service passing the Leadership Simulation Results for the completed Simulation. The Leadership Simulation Results are made up of Performance Scores, the Learner's Activity Log and a record of the ISAP used when launching the Simulation. The Simulation Author is required to ensure that the Simulation Engine he or she chooses can utilize the Leadership Simulation Result format.

3.1.2.4 Prototype Get Simulation

To ease the Phase I Prototype Simulation Engine deployment, Progeny Systems chose to utilize a web service architecture for retrieving the Simulation Script (see section 3.1.1.5) and Default Simulation Adjustment Parameters (see section 3.1.1.2). The Prototype Get Simulation web service provides a standard interface for accessing the Simulation Script and the Simulation Adjustment Parameters used for setting the default Simulation Variable values. The Simulation Engine is expected to call the Prototype Get Simulation web service passing the Simulation's Unique ID. If the Simulation Script is found for the specified Simulation ID the Prototype Get Simulation web service returns the XML formatted Simulation Script and Simulation Adjustment Parameters.

The Prototype Get Simulation web service is only intended to be utilized by the Phase I Prototype Simulation Engine. However, nothing prevents other Simulation Engines from accessing it if desired.

3.1.3 Simulation Environment

To showcase the Data Types and the standard Data Access web services Progeny Systems developed a Prototype Simulation Environment. Some sections of this Simulation Environment were modeled off of existing Army technology and are intended to be replaced with the Army technologies or other commercially available technologies during the Phase II integration efforts. Some of the functionality developed during this effort is only intended to give the Learner or Training Administrator the general idea of what is expected to occur and is not entirely representative of how the prototype system would look or function.

3.1.3.1 Login and Simulation Selection

Normally the Login and Simulation Selection functionality will be handled by the Army Learner Management System (LMS). Since integrating the Simulation Environment into the existing Army LMS was beyond the scope of the Phase I initiative, Progeny developed a basic login process. The login process is based off of the Navy Knowledge Online login method. The Learner is required to enter their Social Security Number, their Last Name and their Date of Birth. If all of these fields match the record stored in the Learner Repository the Learner is signed in to the Phase I Basic LMS (PI-BLMS). The Learner is redirected to the Simulation Selection screen of the PI-BLMS and prompted to select one of the available Simulations to launch. This process would normally be handled by the Army LMS Course Selection feature and is intended to be replaced during the Phase II LMS integration effort.

3.1.3.2 Simulation Engine - Load Simulation

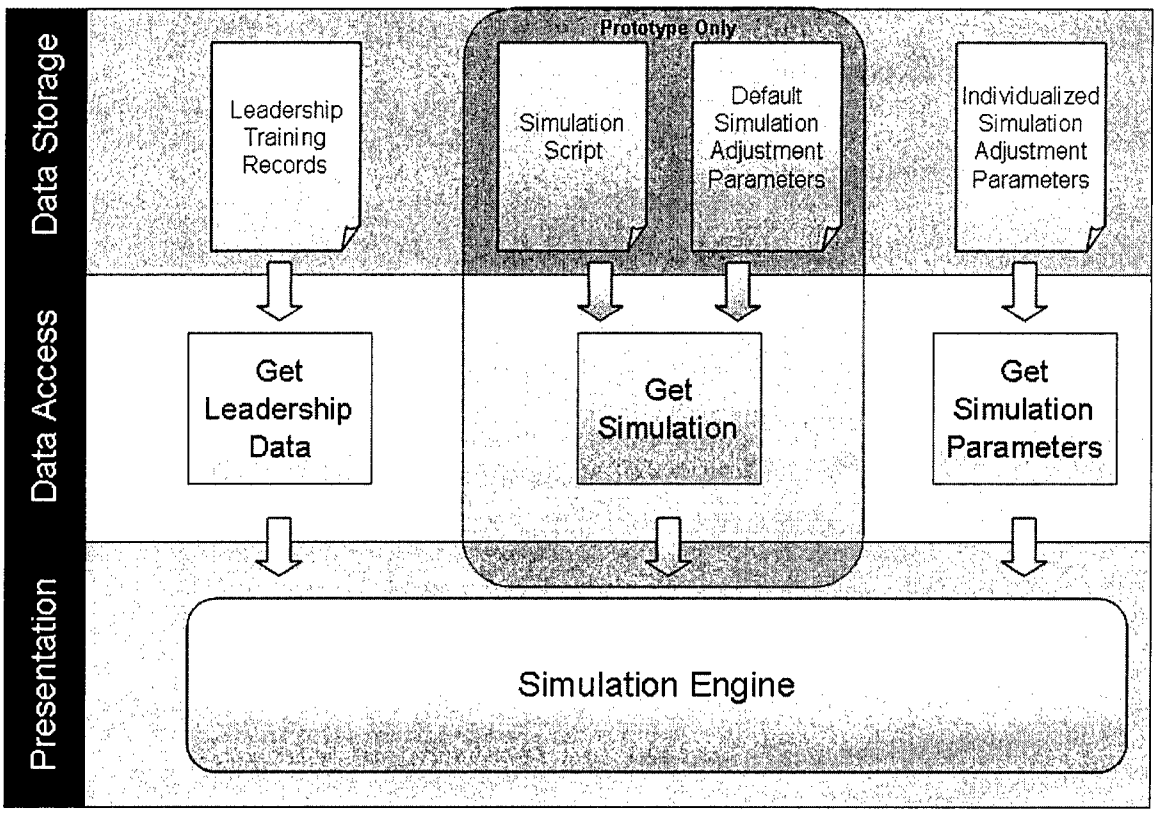


Figure 1 Data Movement - Simulation Start

Figure 1 depicts the flow of data utilized by the Prototype Simulation Engine. With the exception of the Get Simulation process marked as Prototype Only, Figure accurately represents the expected data flow for any Simulation Engine utilized by Simulation Authors.

The Prototype Simulation Engine is passed the Learner's Unique ID and the Simulation's Unique ID by the PI-BLMS. The Simulation starts by calling the Prototype Get Simulation web service (see section 3.1.2.4) to retrieve the selected Simulation and associated Simulation Adjustment Parameters. If the Prototype Get Simulation web service returns an empty XML element, the Simulation Engine issues a "Simulation Not Found" fatal error and exits. Otherwise, the Simulation Engine loads the Simulation Variables defined in the Simulation Script. Next, the Simulation Engine loads the default values stored in the Simulation Adjustment Parameters into the Simulation Variables. Then the Simulation Engine initiates a request to the Get Leadership Data web service (see section 3.1.2.1). After receiving the Leadership Training Records for the specified Learner, the Simulation Engine loads the Leadership Skill values into the associated Simulation Variables if they exist. If a corresponding Simulation Variable doesn't exist for the Learner's Leadership Skill it is ignored since the Simulation is not designed to test or utilize that specific skill. Once the Learner's existing Leadership Skills are loaded the Simulation Engine calls the Get Simulation Parameters web service (see section 3.1.2.2) passing the Learner's Unique ID and Simulation's Unique ID. If the Get Simulation Parameters web service returns Individualized Simulation Adjustment Parameters the Simulation Engine loads the values stored in the ISAP into the Simulation Variables. Finally, the Simulation Engine executes any other Load time code specified by the Simulation Author.

3.1.3.3 Simulation Engine - Execute Script

The Prototype Simulation Engine reads the Root Node from the Simulation Script and passes it to the Node Processing Engine. The Node Processing Engine determines the Node Type and handles its contents accordingly.

Forced Continue Node

To handle a Forced Continue Node (see section 3.1.1.5) the Node Processing Engine displays the Node Text and generates a "Continue" button that references the specified destination Node.

Conditional Redirect Node

To handle a Conditional Redirect Node (see section 3.1.1.5) the Node Processing Engine compares the value of the Conditional Variable to the available Redirect Paths. If the value matches one of the Redirect Paths then the Current Node is set to the Redirect Path's Destination Node and the Node Processing Process repeats.

Decision Node

To handle a Decision Node (see section 3.1.1.5) the Node Processing Engine displays the Node Text and the Node Question. The Node Processing Engine then begins to populate the available actions list by evaluating any Option Requirements. When evaluating Option Requirements the Node Processing Engine compares the Option Requirement Variable value to the matching Simulation Variable value. If the values match then the Option is added to the available actions list.

By selecting an Option or pressing a "Continue" button the Learner modifies the Current Node and the Learner Activity Log is updated. In the case of selecting an Option, Simulation Variable values may be modified. The Simulation Engine then repeats the Node Processing process until it finally reaches the End Node.

3.1.3.4 Simulation Engine - Store Results

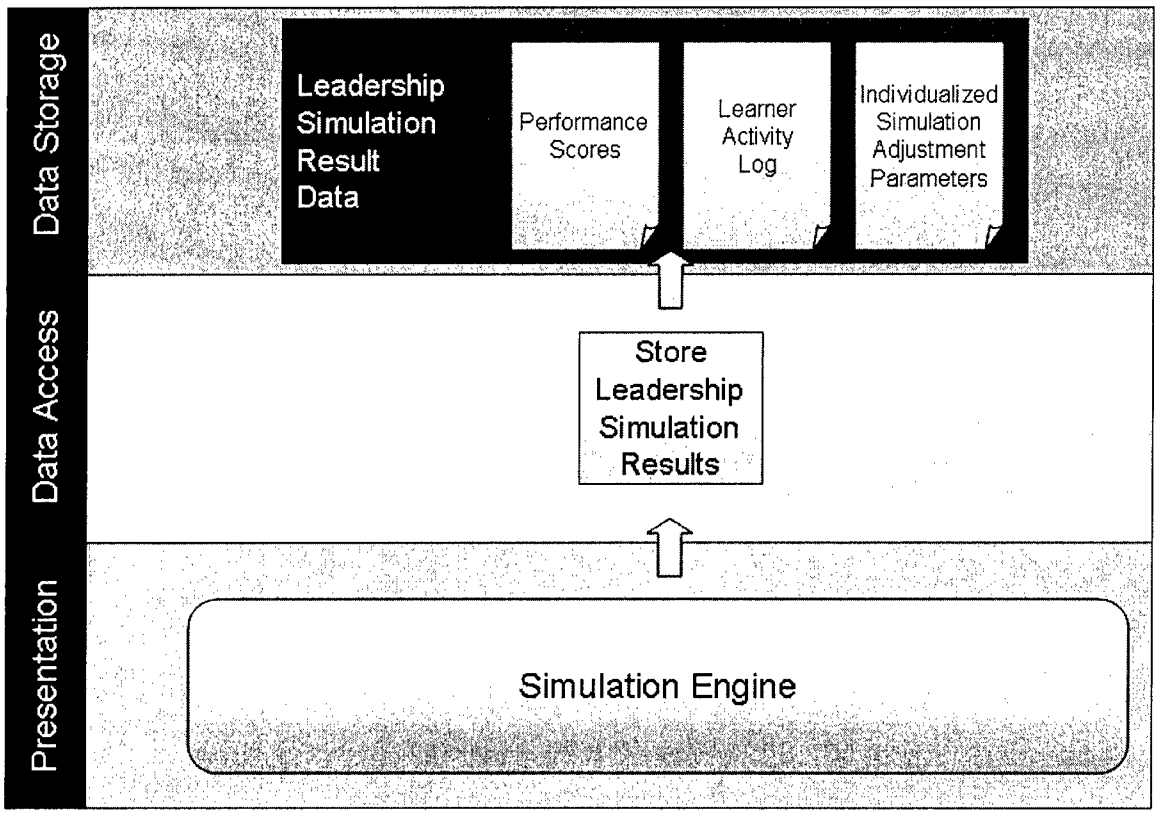


Figure 2 Data Movement - Simulation End

Figure 2 represents the data flow once the Simulation Engine reaches the Simulation End. In the Phase I Prototype Simulation Engine the Simulation End is achieved once the End Node is rendered. The Simulation Engine then processes the Performance and generates scores for the tested Leadership Skills. This data is then packaged with the Learner Activity Log and the initial Individualized Simulation Adjustment Parameters. Finally, the Simulation Engine calls the Store Leadership Simulation Results web service (see section 3.1.2.3) and passes the compiled Leadership Simulation Result Data.

In the Phase I Prototype this data must be manually loaded into the Leadership Training Records for the Learners. Normally this process would be handled by an LMS and it should be automated during the Phase II LMS integration effort.

3.1.4 Data Manipulation Tools

For the Phase I effort Progeny developed 3 primary tools for working with the Data Types used by the Prototype Simulation Environment. Only the Individual Leadership Simulation Adjustment Tool was expected to be a deliverable. The other two will either be replaced by existing Army or commercial technologies during the Phase II effort or simply discarded if they are no longer needed.

3.1.4.1 Individual Leadership Simulation Adjustment Tool

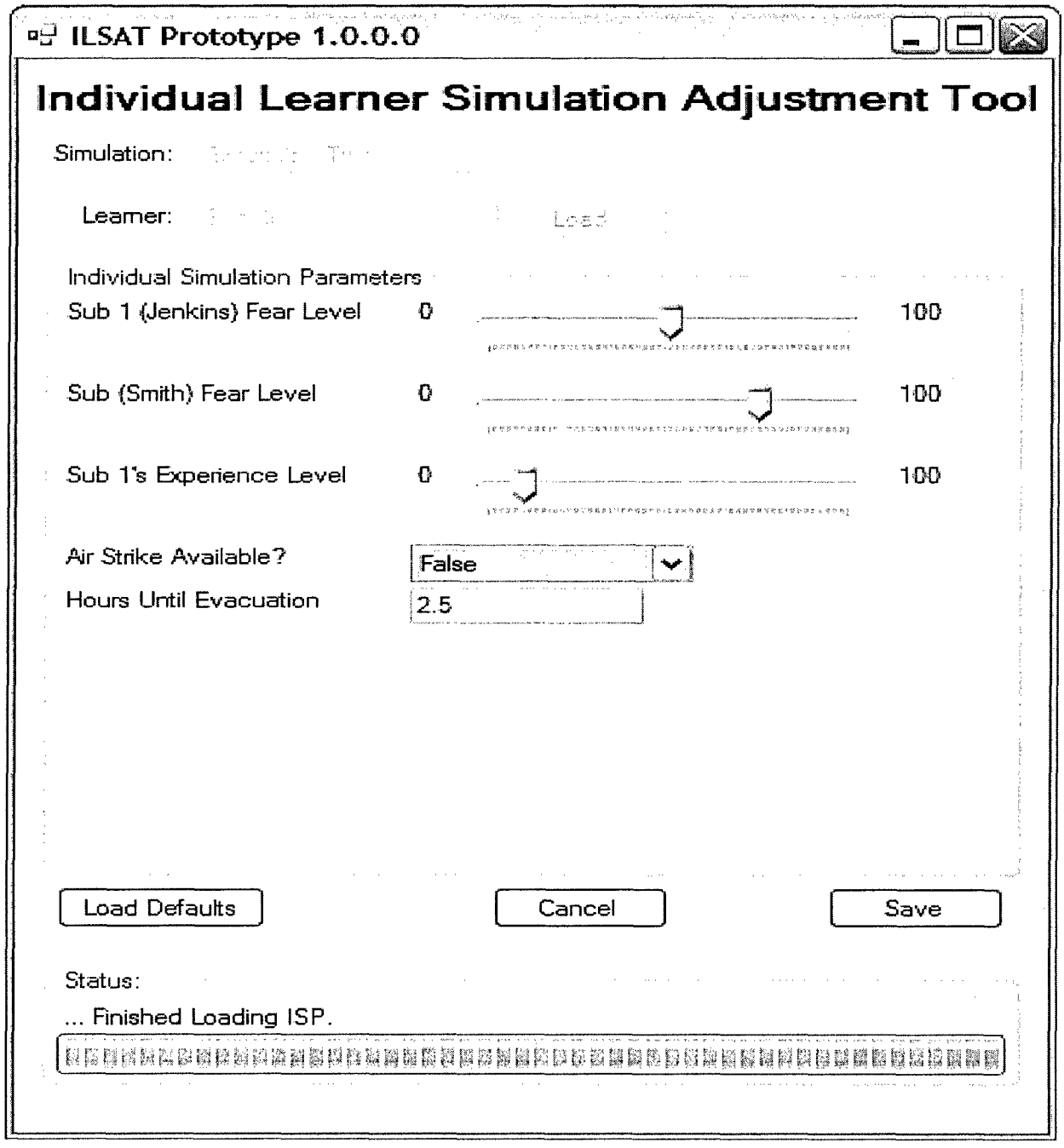


Figure 3 Individual Learner Simulation Adjustment Tool

Figure 3 shows the Individual Leadership Simulation Adjustment Tool (ILSAT) Prototype. This tool is designed to generate the Individualized Simulation Adjustment Parameters (see section 3.1.1.3) for use in the Simulation Engine. The ILSAT Prototype is one example of how the ILSAT could be implemented. It was designed as a proof of concept and determined that most functional requirements that the Army may have regarding system requirements could be implemented at a later date. This version requires the .Net 2.0 framework to be installed on the client machine and utilizes web services to store the generated ISAP on the Prototype Simulation Environment server.

Due to the open design of the ISAP format, the ILSAT can eventually be developed in any Army system requirements compliant environment. The ILSAT implementation technology would simply be required to understand the Simulation Adjustment Parameters (see section 3.1.1.2) to display the appropriate form controls and be able to generate the ISAP formatted results. With these minimal requirements the ILSAT could be easily provided as a web application or imbedded into the LMS.

3.1.4.2 Prototype Learner Creation and Progress Tracking Tool

The Learner Creation and Progress Tracking Tool (LCPTT) was developed to provide an administrative interface for the Phase I Basic LMS (PI-BLMS). This interface gives administrators the ability to create, modify and delete Learners in the system. It also provides a method for creating, modifying and deleting existing Leadership Skills for each user. This tool is intended to be replaced by the Army LMS during the Phase II LMS integration effort.

Prototype Simulation Script Builder

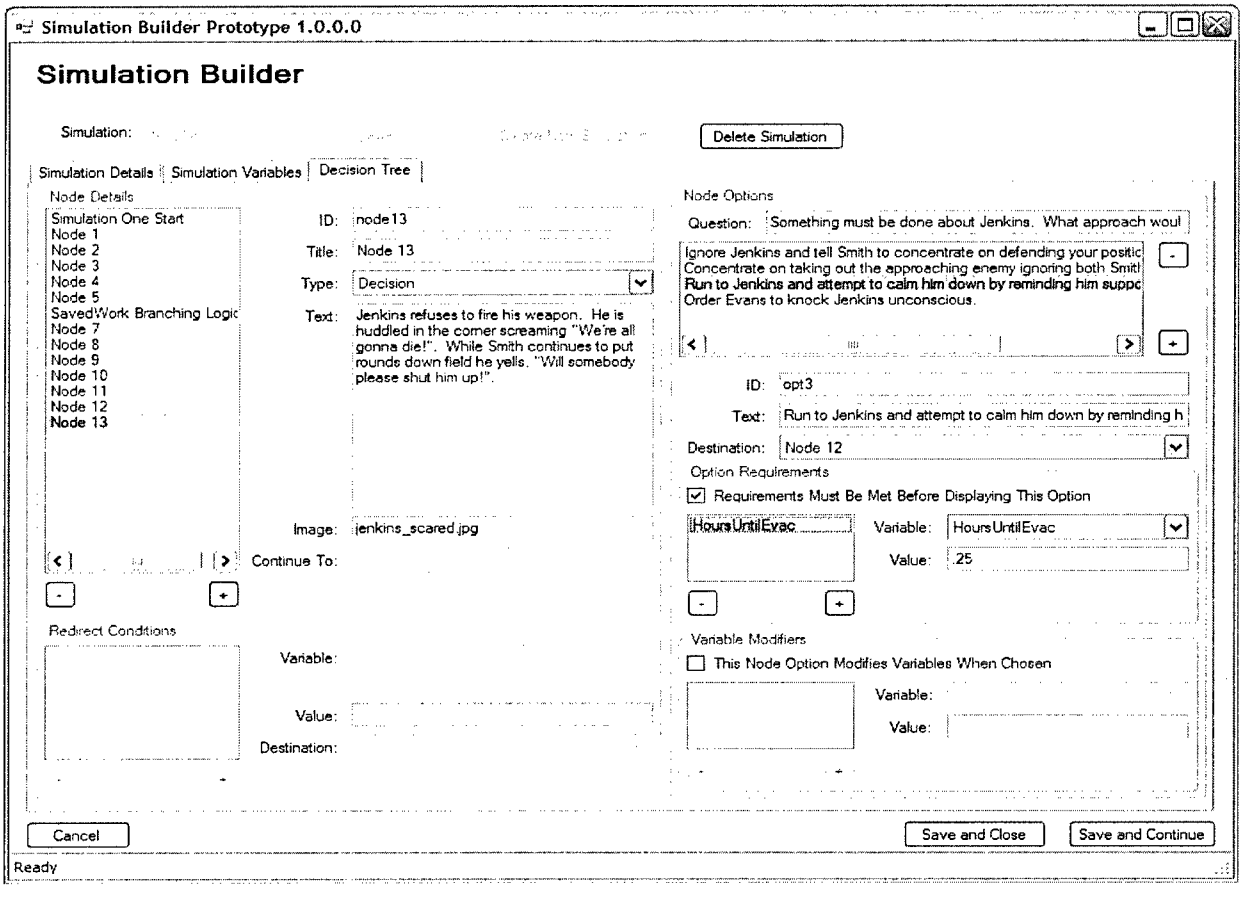


Figure 4 Prototype Simulation Script Builder

Figure 4 shows the Decision Tree tab of the Prototype Simulation Script Builder. While developing sample Simulation Scripts, Progeny discovered that it was very tedious and error prone to write the required XML by hand. Progeny solved this problem by developing the Prototype Simulation Script Builder. This tool allows the Simulation Author to define all of the Simulation Variables and Decision Tree Nodes in a rapid and easily understandable manner. Simulation Adjustment Parameters are also generated based off of parameters set when creating Simulation

Variables. This tool will either be altered or abandoned, depending on the use of Simulation Scripts in the Phase II effort.

3.2 Research into Gaming and Simulation Technologies

See Appendix B

Part of Progeny's original Phase I proposal included the development of a simulation or gaming environment to support the rapid prototyping of scenarios for the purpose of leadership assessment. Through discussions with the sponsor, this effort was redirected to the research and effort described above. However, since the phase II effort may include the development of a more immersive assessment environment, the evaluation and results of the gaming engines is included.

The results for the Phase I prototype effort pointed to the use of Macromedia Flash. While not as easy to develop simulations with initially as some of the other engines Progeny intended to release the code that powers the prototype simulation. This code can be utilized by future simulations to reduce development time. The primary reason why Progeny chose to utilize Flash for the Phase I prototype is its ability to be deployed over the web. Progeny will not have to develop extensive code to deliver Flash simulations through existing LCMS software such as OutStart's Evolution. This will greatly reduce the work needed to build an effective training simulation prototype. Since the gaming development aspect of the phase I effort was deprecated, the analysis as to the preferred gaming engine will be revisited if Progeny is awarded a Phase II.

4 Theoretical Framework

The other major effort of this phase I project has been a review of relevant literature to further refine the technical efforts as well as to create a theoretical foundation for the Phase II objectives. The research primarily focused on reviewing the literature in the Leadership domain (both military and public sector). It is important to note an underlying assumption of the leadership construct is that leadership is multi-dimensional. Figure 5 presents a method similar to the Navy's 5 Vector Model to show how an individual could be assessed across a multi-dimensional construct like Leadership. An individual could be rated anywhere on the continuum of multiple independent dimensions (*note: independent meaning that the dimensions are assessed with different instruments, not necessarily that the dimensions are not correlated in some way*) that when taken together would allow for an assessment of the whole multi-dimensional construct. The relationships between the dimensions would not have to be fixed, rather certain dimensions could be weighted higher based upon their predictive capability or overall importance. The methodology also supports the potential of non-linear interactions or combinations of the dimensions. In other words a "High" score on A, and B and a low score on B, C and D might lead to an overall assessment greater than a "Medium" score on all dimensions. Through the utilization of this sort of methodology, Progeny systems can develop the overall leadership assessment center in a phased approach as well as take advantage of existing research. To put differently, the sponsor can add or remove Dimensions as funding, available research or needs change without affecting the existing dimensions in the Leadership Assessment Center.

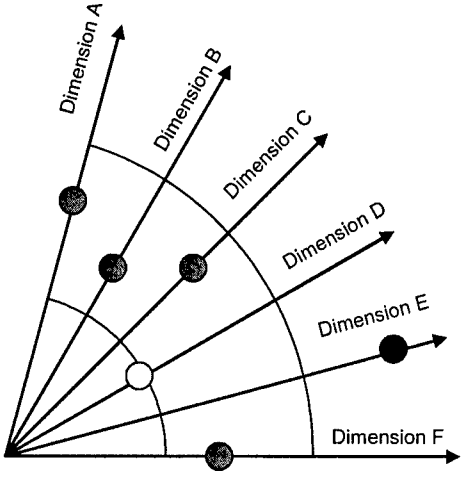


Figure 5: Multidimensional view of the Leadership Construct

Another underlying assumption of the Leadership construct is that it can be modeled in some sort of continuous distribution. To state differently, Leadership is not a construct that a person either has or does not have (binary distribution), but rather people have different levels of leadership. While the distribution of the leadership ability may not follow the normal distribution pattern, Figure 6 represents a nominal curve by which leadership may exist. The continuous distribution assumption leads to a few difficulties that while out of the scope of this proposal are interesting to note. One difficulty arises from if one wishes to use the leadership construct for job selection. It would seem that if one could argue that person A is objectively a better leader than person B by some measured amount, then person A would be a better candidate. However, both candidates could surpass the threshold for the necessary leadership for a job. In this situation, the job selection should depend on some other measurement, but without the ability to create thresholds of perfomance needed for certain jobs or taks, a validated Leadership measure might create new problems.

The last assumption Progeny made with regard to the leadership contruct was that leadership performance can be improved via training and external aids. This last assumption is important because if leadership performance was fixed then true thresholds of performance could be set. To put differently, one could assess individuals along the leadership construct and if they didn't surpass a specific "cut score" then they would be ineligible for a certain job. However, since our assumption is that leadership performance can change over time, a primary benefit for measuring leadership performance is not so much as a selection criterion, but rather as a training aide like learning tactics or measureing of performance for weapons handeling. There would be some utility for job selection, but the task of figuring out the overall capacity for leadership performance is fundamentally different than measuring someone's current performance. It is possible that over time correlations would be begin to occur such that if a junior officer obtains a certain score then their overall capacity might be inferred. However, this line of research is out of scope for this proposal.

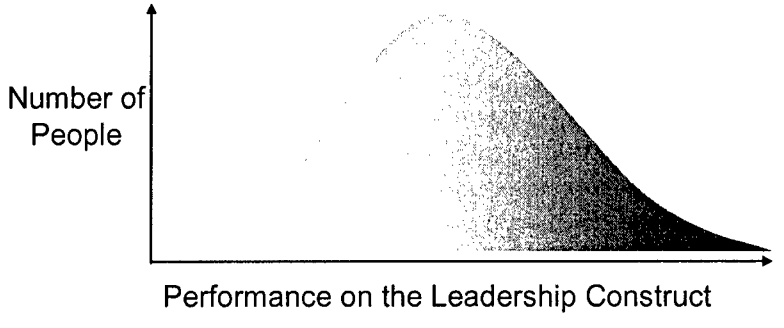


Figure 6:Leadership Performance Curve

The main objective of defining the assumptions and investigating the literature on leadership, assessment centers and other related topics was to determine if one could create a set of measurement dimensions that could be used in multiple domains, multiple situations and with multiple levels of user experience. Additional research was conducted to create a theoretical framework for how feedback interventions should be handled with the overall stated goal of increased leadership performance.

4.1 Role of Feedback on User Performance

One of the primary issues with creating a computer-based assessment center is what one does with the data that is collected from the simulation or user interaction with the system. Computer Based assessment centers are used in a variety of locations and for a variety of reasons. With respect to the current research, Progeny systems had to determine if the provided solution should just assess and report on a user's performance or if the system should also have some functionality to help improve users' performance over multiple trials of the system.

The literature on the utility of feedback interventions for increasing performance was a valuable line of research. Of particular value was *The Effects of Feedback Interventions on Performance* (Kluger and DeNisi 1996). Kluger and DeNisi discussed how certain types of feedback interventions were beneficial in certain arenas and could in fact be detrimental to performance in different areas. For example, Kluger and DeNisi's research shows that when a user received a feedback intervention, his or her reaction to that intervention depends on where on the standard they were rated. If the user was rated below a standard, most people tended to increase their effort to get up to the standard measure. However, in cases where the person scored above a certain measure people tended to either maintain or reduce their effort. This finding applies to the multi-dimensional leadership construct because if users receive feedback that they meet or exceed the standard on certain dimensions of leadership they may reduce their effort on those dimensions in order to reallocate their focus to dimensions where they might have missed the standard. Why on the surface, this approach seems logical, the users may actually decrease their performance because as discussed above, not all dimensions are weighted equally, the interactions be dimensions might be complex, some dimensions might be fixed (i.e. people cannot work at increasing their I.Q), or they may "overshoot" the effort necessary and thusly not only continue to miss the standard on the original dimension, but also miss the standard on a dimension they previously "passed."

Lastly, Kluger and DeNisi discussed the impact of feedback intervention on the "locus of attention" for users. They stated that if a feedback intervention shifted the focus of attention from its nominal location in the middle of the Feedback-loop Hierarchy up to the "Self" component then performance is generally degraded. They posited several hypotheses for why performance degrades, but with respect to Progeny proposed solution, it is sufficient to note that the feedback intervention should try to focus the attention down the hierarchy to the "task detail" level. Kluger and DeNisi also made suggestions about how the feedback intervention should be structured so that that the users do not begin to modify successful decision making strategies. Therefore, it is imperative that the feedback interventions be structured such that the users receive guidance on where the errors could be occurring or methods that might lead to error reduction.

The line of research into the effects of feedback intervention have specific impacts to Progeny's proposed solution:

- Feedback interventions need to be structured such that it enables users to accurately determine areas where additional effort is most likely to increase performance on the leadership construct.
- Feedback interventions need to focus user on tasks and provide areas of improvement
- Feedback interventions need to change style and format depending on the task characteristic
- The Leadership construct is a "long duration" attribute and as such should be measured over a long period of time
    - Corollary: When "long duration" attributes are sufficiently practiced, existing user resources (i.e. Intelligence, Multi-tasking construct) become less predictive.
- The effect of Feedback interventions change with differences in situational variables
- Personality traits of the users change the impact of Feedback interventions

4.2 Leadership Behavior Taxonomy

The literature is littered with different sorts of leadership behavior taxonomies. Some of the taxonomies focus on the general effect of leaders. For example, Fleishmen (1953)[1]; Halpin & Winer (1957)[2]; and Blake & Mouton (1982)[3] categories leadership behavior in to two broad "metacategories." These "metacategories" can be best described as relations-oriented behavior and task-oriented behaviors. Relations oriented behaviors are behaviors that influence a subordinates actions based upon social and organizational relationships. For example, a relation-oriented style might entail a manager using his or her personal relationships with a subordinate to get that subordinate to work harder, or to change maladaptive behaviors. Task-oriented behaviors focus less on the interpersonal relationships between the leader and the subordinate, and focus more on the specific nature of the task. Task-oriented behaviors rely on well defined organizational structure, a clear hierarchy or chain of command, and well defined tasks and goals. Yukl, Gordon and Taber (2002)[4] argue that in addition to task and relation oriented behaviors a third metacategory exists. This third category is best described as change-oriented behaviors. Unlike the other two metacategories, change-oriented behaviors capture the more coaching or performance enhancing behaviors leaders' exhibit. An example of change behavior leadership would be when a leader discusses a change in presentation style to a subordinate, or more topically, when a commander suggests a change in tactics or actions of a Soldier.

Yukl, Gordon and Taber (2002) define 12 specific leadership behaviors. While these behaviors are more suited for civilian leadership than military leadership, they do provide a framework by which Progeny created a theoretical framework:

- Clarifying Roles: Assigning tasks and explaining job responsibilities, objectives and performance expectations.
- Monitoring operations: Checking on the progress and quality of the work, evaluation of individual and unit performance.
- Short-term Planning: Determining how to use personnel and resources to accomplish a task efficiently, and determining how to schedule and coordinate unit activities efficiently.
- Consulting: Checking with people before making decisions that affect them. Encouraging participation in decision making and using ideas and suggestions of others.
- Supporting: Acting considerate, showing sympathy and support when someone is upset or anxious and providing encouragement and support when there is a difficult, stressful task.
- Recognizing: Providing praise and recognition for effective performance, significant achievements and special contributions and performance improvements.
- Developing: Providing coaching and advice, providing opportunities for skill development, and helping people learn how to improve their skills.
- Empowering: Allowing substantial responsibility and discretion in work activities and trust people to solve problems and make decisions without getting prior approval.

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[1] Fleishman, E. A (1953). The description of supervisory behavior. *Personnel Psychology*, 36, 1-6

[2] Halpin, A. W., Winer, B. J. (1957). A factorial study of the leader behavior descriptions. In R. M. Stogdill & A. E. Coons (EDs.), *Leader behavior: Its descriptions and measurement.* Columbus, Oh: Bureau of Business Research, Ohio State University.

[3] Blake, R.R., & Mouton, J. S. (1982). Management by grid principles or situationalism: Which? *Group and Organization Studies*, 7, 207-210

[4] Yukl, G., Gordon, A., & Taber, T. (2002). A Hierarchical Taxonomy of Leadership Behavior: Integrating a Half Cnetury of Behavior Research. Journal of Leadership and Organizational Studies, Vol. 9, 1, 15-32.

- Envisioning Change: Presenting an appealing description of desirable outcomes that can be achieved by the unit, describing a proposed change with great enthusiasm and conviction.
- Taking Risks For Change: Taking personal risks and making sacrifices to encourage and promote desirable change in the organization.
- Encouraging Innovative Thinking: Challenging people to question their assumptions about the work and consider better ways to do it.
- External Monitoring: Analyzing information about events, trends and changes in the external environment to identify threats and opportunities for the organization unit.

Yukl, Gordon and Taber (page 25, 2002)

4.3 Naturalistic Decision Making

The previous two bodies of literature were focused on how to provide feedback to users, and a potential framework for leadership behaviors that could be captured. This section of literature was based upon how one would create a scenario to assess users on the leadership construct. Progeny Systems had the goal of creating scenarios for different environments in a quick and efficient manner. One of the major limitations of many existing simulation or computer-based environments is that it takes an inordinate amount of time to develop new material when enemies change their tactics or when new combat theatres emerge. Progeny's goal was to create situations that transcend situational details such that if a combat theatre was in a jungle or a desert, only small, unobtrusive aspects of the tool need to change. The concept was that while tactics might change dramatically based on terrain, or environmental cues, the act of leadership would more or less stay unchanged. In an effort to define the characteristic of a situation that are essentially immune to external situational characteristics, Progeny investigated the literature surrounding naturalistic decision making. Klein et. al.[5] proposed 10 traits or features that lead to naturalistic decision making:

- Ill-defined goals and ill-structure tasks
- Uncertainty, ambiguity and missing data
- Shifting and competing goals
- Dynamic and continually changing conditions
- Action-feedback loops (real-time reactions to changed condition)
- Time stress
- High Stakes
- Multiple players
- Organizational goals and norms
- Experience decision makers

The Klein et. al. model fits will within the military domain as none of these characteristics are violated. Through the use of these features, Progeny's proposed solution allows for a leadership assessment of an individual *independent* of situational variables such as operational theatre, enemy tactics or other similar characteristic. Via variable independence, Progeny's proposed solution

[5] Klein, G. A., Orasanu, J., & Calderwood, R. (1993) *Decision Making in action: Models and methods.* Norwood, NJ: Ablex Publishing

provides a greater ability to create simulations or assessment scenarios quickly and in a wide domain while keeping controlling internal validity.

5 Conclusions

The research developed as part of this Phase I effort highlighted that while the literature has numerous theories on leadership and taxonomies for categorizing leadership behaviors, there is very little work on actually measuring and creating a predictive capability for assessing a person's leadership potential. Progeny Systems' approach was to use gaming, web, and learning management technologies to produce a proof-of-concept assessment center for the multi-dimensional leadership construct. The following section describes the results of the Phase I effort:

While the Leadership construct is multi-faceted, its different dimensions can be measured effectively via an assessment center whose foundation is a commercial learning management systems (LMS)

Current Learning management systems are able to present users with a variety of multi-modal learning and testing options. Through the use of commercial LMSs Progeny has the ability to take existing, mature paper or computer based assessment batteries for any of the dimensions in the leadership construct and both present them to users and store the results for assessing the different dimensions of leadership.

Through an innovative adaptation of the SCORM 2004 standard, Progeny also worked through the concept of delivering simulation and other assessment stimulus in a "chunked" presentation format. By "chunking" the data, Progeny Systems plans to be able to create a more granular, prescriptive presentation capability than what currently in the industry. To state differently, instead of having a large simulation and assessment batteries that tests all users in the same way, Progeny proposes to present different aspects of simulation and assessment batteries based upon user experience, training and other characteristics that vary from person to person.

By distinguishing between situational variables that only provide context to decision making from those variables that actually can be used to assess different dimensions of the leadership construct one can reach a high degree of reuse

The literature has defined characteristic of situations that can be used to study a person's decision making ability. Therefore one can construct situations where one could measure specific aptitudes or problem areas in a user while also retaining the ability to vary extraneous situational characteristics. In other words, one could develop a situation where the fundamental measure of a leadership dimension is unchanged, but external variables like weather, location, and enemy tactics could all be changed. This methodology allows for a high degree of material reuse since one training or simulation environment could be changed so as to almost be unrecognizable from the original training environment, but still measure the same dimension of interest. This innovation provides a huge cost savings as the sponsor could reuse material in a jungle theatre that was originally developed for a Desert or Artic environment.

Both immersive and textual "simulation" can be used to measure dimensions of the leadership construct

The gaming industry as well as a good amount of the academic research has focused on immersive simulations in order to train users in certain behaviors or to study and assess how a user will react when given a certain set of stimulus. With respect to the leadership construct, one can gain information about a user along the whole continuum from highly immersive, to textual representations of problem spaces. Progeny proposes to start with a textual interaction with the user to capture decision making and relevant behaviors and eventually to mature into a more immersive technology realm. Textual representation facilitates quick scenario development as well

as a more controlled solution set that affords vastly reduced complexity during user assessment. As technologies mature and Progeny's understanding of the domain increases, the ability to gather information in real-time from a user's "behavior" in a immersive simulation will increase the external validity of the assessment as well as provide a more granular assessment due to the exponentially increased size of the potential solution set. In other words, the textual representation provides a only a handful of behavioral options while an immersive simulation provides nearly unlimited options.

6 Phase II Technical Objectives and Approach

The primary objective of the proposed Phase II effort is to develop a prototype leadership assessment center. In order to create an assessment center of any type it is necessary to define the dimensions by which one is going to assess users. In the specific case of the multi-dimension construct of leadership, one needs to create a multi dimensional assessment center that is able to measure user performance on individual dimensions while also collecting the results from the entire dimension to come up with an integrated "raw" assessment of the overall construct. The proposed innovation will utilize a methodology similar to that of the Navy's Five Vector Model that tracks individual Sailor progression along five distinct dimensions in order to determine the individual's relative performance to his or her peers. The assessment center will provide a raw "score" for each identified dimension that then rolls up for the overall assessment. Depending on the needs of the Sponsor the results of the individual dimensions could be shared with the user as part of a feedback intervention, or could be kept in confidence so as to not allow a user to "game" the system or potentially reduce the users performance consistent with the research described in section 1.4.1.

An important task that is related to the primary objective is the definition of the different dimensions of leadership. A validated set of dimensions might even be considered the starting point of a fully implemented assessment center. Progeny's approach is to provide the sponsor with the capability to easily create, maintain and track dimensions as research continues. Through the use of a Service Oriented Architecture (SOA) and a commercial Learning Management System (LMS), Progeny already has all the tools necessary for fleshing out the assessment center with as many dimensions as the Sponsor deems necessary. So instead of proposing to define the list of all the dimensions of leadership, Progeny is proposing innovation in defining and capturing behaviors that are predictive for leadership, providing feedback interventions that are tailored to the situation and user and creating a method for rapid deployment of scenarios by creating simulations or scenarios that measure leadership behaviors in a situational-agnostic manner. It is argued that through the use of existing Progeny technologies, systems and experience, additional dimensions can be added easily. For example, a probable dimension for predicting leadership performance is general aptitude (i.e. intelligence). There are numerous IQ tests that are web based, (IEEE standards Compliant) that could "play" on Progeny's existing infrastructure. If general aptitude is identified, then it is a simple issue to integrate that existing application into the proposed solution. Another example might be a dimension for Leader empathy. It is hard to define a computer based method for measuring a user's empathy. Despite the difficulty in quantifying such a concept, there are numerous paper based and interview-style instruments that try to provide a quantified score of empathy. If the sponsor chooses a paper based instrument, then it is a simple step to convert the instrument to a web based tool. It could also be possible through a more immersive simulation environment to track exactly what a user does within the scenario. Some of the gaming engines described the previous section have a first person perspective so it would be possible to capture if a user "looks" at subordinates "talks" with them or just "commands" them into action. Progeny proposes to support even instructor led, free-form interview style assessment instruments via an integration stroke with a commercial-based LMS. Progeny proposes to spend the effort on the creation of the infrastructure necessary for a fully functional assessment center that could then be used for other constructs

besides leadership, instead of conducting the research, creating Critical incidents and holding focus groups necessary to create another description of the leadership construct. That being said Progeny Systems intends to further review the leadership literature as well as work with the sponsor and other subject mater experts to develop and define a subset of the overall leadership dimensions.

The purpose of having some of the dimensions, but not an all inclusive set is two fold. First, it allows Progeny to accurately test multi-modal (i.e. Web-based content, translating paper based content, interview-style content, etc.) dimensions. Through the prototyping of multi-modal dimensions Progeny will demonstrate the capabilities of its existing technologies and systems and measure their applicability to the general concept of assessment centers. The second benefit is that the prototype provided to the sponsor will have some predictive ability and potentially could be used with real users while additional dimensions are defined and validated. Essentially, the approach provides the sponsor with a phased implementation plan that allows for refining the proposed solution at multiple points and as more data becomes available.

6.1 Embodiment of Theoretical Foundations

Progeny has developed a functioning proof of concept of the system described in section 1.1 that is based on the research laid out in the section 1.4.1, 1.4.2 and 1.4.3. The proof of concept application shows that Progeny can take a scenario as described in the *66 Stories of Battle Command* and capture user inputs, report out the inputs and score them against a predefined construct of leadership. The follow sections describe how Progeny proposes to mature those capabilities in a Phase II environment

6.1.1 Leadership Behaviors

Progeny proposes to continue to refine the concepts behind the leadership construct by more fully fleshing out the list of behaviors that typify effective or highly effective leadership. It is out of scope to create a fully qualified (or validated) list of leadership behaviors, but a representative subset could be defined through a number of potential methods. One method would be to conduct a focus group and follow the standard critical incident technique. However, such a method would require many subject matter experts and well as several hundred critical incidents in order to meet the statistical requirements. Another method would be to utilize the dimensions described in the FM22-100 as a foundation for the creation of a finite set of behaviors. This method would utilize the dimensions that the Army has identified as key to the leadership construct and provide a facilitated mapping between leadership dimension and measured behavior. Some effort would have to be expended to verify and/or validate that the behaviors identified for each dimension actually measured that dimension, but that effort should be nominal. One last approach would be to further investigate the literature and try to determine which behaviors have been studied in the past and how those behaviors map to the dimensions listed in FM22-100. Progeny proposes to utilize a combination of the last two methods described. The research conducted as part of the Phase I effort, showed that one could create a behavior taxonomy by investigating the literature, but that the literature was not always well suited for military domains. Issues like strict hierarchy and compelled compliance are not prevalent in the civilian world or the research that studies civilian leadership behaviors. The proposed methodology for creating the measurement behaviors for the leadership construct is sufficient for Progeny's overall objective of creating a proto-type leadership assessment center. For a fully mature assessment center, one would have to be assured that *all* behaviors were captured and assessed. However, with the bar somewhat lowered by prototyping the design Progeny is concerned more with validating the approach, rather that having a 100% valid assessment. That being said, it is hoped that even though the proposed solution is less than fully validated, it would still offer some predictive or diagnostic capabilities.

6.1.2 Feedback Intervention

The literature describe above gives a fairly detailed accounting and framework for how feedback should be given to user depending on the situation faced by the user and depending on the overall task characteristics. In order to maximize user performance, the types of feedback, the interval of when to provide feedback and the level of specificity of the feedback all need to be variable. Progeny proposes to create a codified methodology that take user-specific attributes (i.e. training, experience, previously defined dimensions of the leadership construct) and situation specific attributes to define the relevant feedback intervention characteristics. In other words, the proof-of-concept already is able to change complexity of the scenario based upon user-specific data, so it is a logical extension that the types of feedback could also change based upon this data. For example, the literature described how the more practiced a task was the less of an impact a feedback intervention had in certain situations. In those situations a junior officer might have a feedback intervention while a less junior officer received no feedback at all. The feedback intervention strategy would try to optimize performance by avoiding known problems areas. To date, variable feedback intervention is not prevalent in the leadership domain and represents an innovation that could provide the proposed solution a marked improvement over other solutions that only provide one type of feedback or that do not utilize all available and relevant data about the user. This concept could be further extended to use personality traits, educational background, or even learning styles for how feedback intervention is handled.

6.1.3 Naturalistic Decision Making

The proof of concept developed for Phase I utilized the *66 Stories of Battle Command* to develop a meaningful scenario to test out the concepts developed within the overall research line. However, for the more robust system to be done as part of the Phase II effort, Progeny proposes to utilize the approach described in the naturalistic decision making literature to create situations that transcend situational characteristics. In other words, tactics might change dramatically based upon something like terrain, but how a leader handles a scared subordinate or exhibits other leadership behaviors arguably do not change based upon such variables. Progeny proposes to use the ten features of naturalistic decision making as constraints for scenario development. In other words, a scenario could be developed like one in the proof of concept or like one of the stories in the *66 Stories of Battle Command* that uses features like time stress, ill-structured tasks, and high stakes to elicit assessable leadership behaviors. However, unlike the existing stories which provide the details for how a person could be assessed, Progeny proposes that situational details just become the **context** of the assessment. Like the proof of concept, the proposed prototype would measure the presence or absence of defined behaviors, and methods of leadership exhibited by the user. The description of the weather, location or other variable would only be value as a framing concept to the user. This methodology would allow for very rapid scenario creation as the collection of situations could be stored and then replayed in different environments or theatres as enemies change their tactics or as new threats emerge. This methodology stands in stark contrast to solutions that require long lead times due to the highly coupled nature of the situational variables to the assessment instrument.

7 Phase II Work Plan

7.1 Define subset of Leadership Dimensions

In order to provide the sponsor with a functioning and useful prototype, Progeny must define a set of dimensions that could be used in the assessment of the leadership construct. In order to provide a better demonstration of the capabilities of the proposed innovation, the defined dimensions will be multi-modal (i.e. Web content and paper-based content). In order to define the selected dimensions, Progeny will utilize a thorough literature review, work with subject matter experts as well as work with the sponsor to determine if certain dimensions are more interesting or line up with related Army research topics.

7.2 Integrate Leadership Dimensions with existing Progeny Technologies

Once the dimensions are defined, they must be integrated into the overall solution. It is assumed that this effort will be trivial, but necessary in order to prove out the overall concepts of the proposed solution set

7.3 Defined Leadership Behaviors

As with leadership dimensions but on a grander scale, there are many more leadership behaviors that could be captured and measured than are described in the previous sections. Progeny has identified twelve high-level behaviors based upon a literature review. These 12 behaviors need to be further refined such that each of the high level behaviors has 3 or 4 sub behaviors. By increasing the number of behaviors, Progeny's solution also for extra granularity in the assessment of how an individual exhibits leadership. Additionally, if the future research shows that one or more of the sub-behaviors are invalid measures, there are still items mapped to each high level behavior.

7.4 Implement Variable Feedback Technique

As described above, one of the proposed innovations of Progeny's solution is the ability to change the type, style and temporal location of a feedback innovation. The relevant characteristics of the user and the situation need to be captured and made available to the system. Related to this item are tasks associated with the creation of a taxonomy of complexity for a particular scenario. Kluger and DeNisi provide one methodology to assigning a complexity level to a situation. Progeny systems intends to research additional methodologies and pick the "best of breed" so to quickly, accurately and consistently assign a complexity rating to a given scenario.

7.5 Naturalistic Scenarios

The proof of concept described in Phase I result section shows a tool for creating scenarios in a relatively easy and straight forward manner. For the prototype solution, this scenario engine will be extended to encompass the concepts described in Naturalistic Decisions Making in order to create assessment scenarios that are not tightly coupled to situational variables. The ten traits of naturalistic decision making will be incorporated into the proposed innovation such that a scenario developer can create an assessment event for one situation and then reuse the same event for a different situation at a later date.

7.6 Evolve Simulation Delivery System

Progeny Systems will continue the effort started with the Phase I Prototype Simulation Delivery System to provide an easily deployable and effective Leadership Training Simulation Environment. The development process will target three main sections.

7.6.1 Immersive Simulation Engine

During the Phase I effort Progeny Systems developed a Prototype Simulation Engine to demonstrate the back-end data access web services. Progeny will work with Commercial Vendors to either extend the capabilities of the Prototype Simulation Engine or completely replace it. The end goal is to provide Simulation Authors an immersive Simulation Environment that is capable of measuring more Leadership Characteristics than the original Prototype.

7.6.2 Simulation Script Capabilities

Progeny will evaluate the feasibility of utilizing the Prototype Simulation Script format with the new Immersive Simulation Engine. Based on the feasibility evaluation results Progeny will either extend the Commercial Vendor's Simulation Authoring format to utilize Simulation Adjustment

Parameters or extend the existing Simulation Script format to support the advanced Leadership Characteristic measurement capabilities found in the new Immersive Simulation Engine.

7.6.3 Leadership Performance Measurements

One of the primary thrusts of the Phase I effort involved researching Leadership Performance measurement techniques. While Progeny determined an effective method for assessing Leadership skills in a Simulation Environment, the selected metrics were limited by the Simulation Engine technology. For the Phase II effort Progeny will revisit the Phase I research to identify new metrics that are available due to the new Simulation Engine technology. Examples of potential new measurable Leadership behaviors are effective Eye Contact and Listening ability.

7.7 Integrate Leadership Assessment Center with AKO

One of the main goals of the entire A05-025 project is to easily deploy Leadership Skills Assessments and Simulations to the Soldiers. Rather than spend time and money developing a proprietary delivery mechanism Progeny proposes to utilize the Army's existing learning content distribution tool. Army Knowledge Online provides a standardized way for Soldiers to access learning content. Progeny will utilize their experience with Navy Knowledge Online to integrate the Prototype Leadership Assessment Center with the AKO LMS.

7.7.1 Research the Army LMS

Progeny will begin this effort by thoroughly researching the LMS capabilities provided within AKO. Progeny will utilize existing relationships with Commercial Vendors to address any shortcomings in the AKO LMS. The LMS research will dictate how the other sections of this effort are conducted.

7.7.2 Learner Training Records

The Phase I effort required Progeny to define the format used for storing records of Leadership Skills. Progeny elected to model it off of NKO style Learner Skill records. Based upon the Army LMS research the Learner Training Record format may need to be modified or expanded to function in the Army environment. Progeny will work to mimic AKO style performance measurement formats with the updated Learner Training Records.

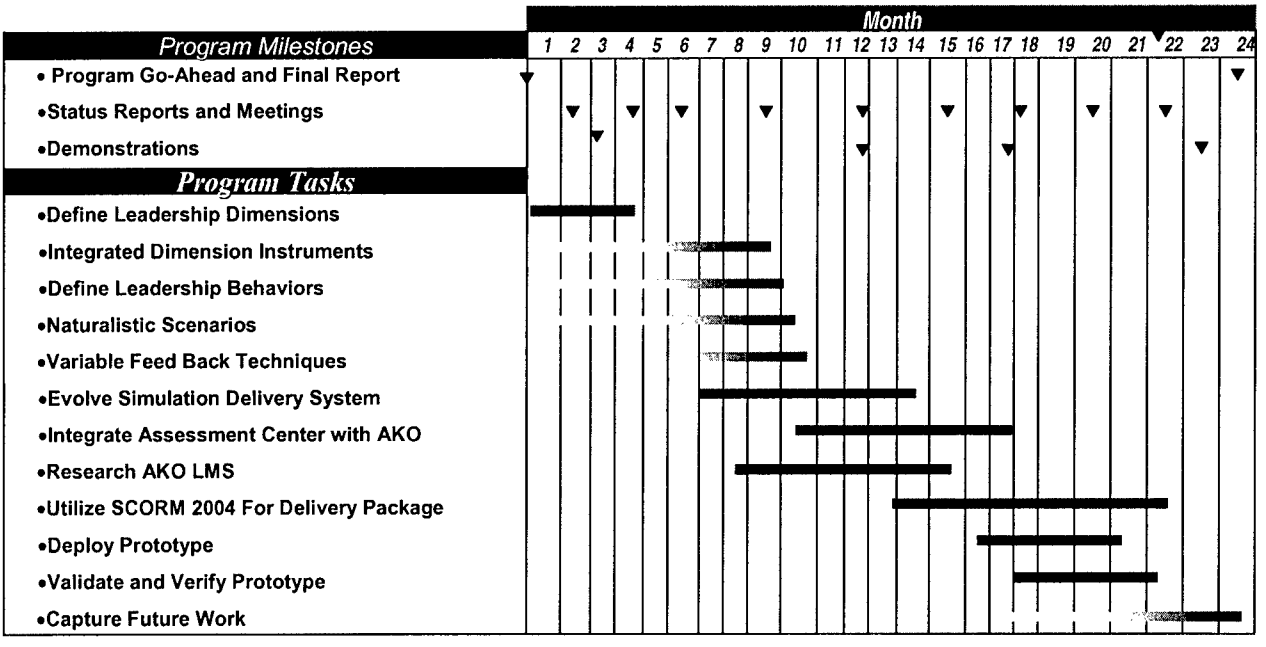
7.7.3 Utilize SCORM 2004 for Simulation Delivery

The Phase I Simulation Environment relied on web services for delivering the simulation content to the web based Simulation Engine. For the Phase II effort Progeny intends to utilize a standard method for delivering content that is supported by most LMS and LCMS solutions. Progeny will research the feasibility of encapsulating the Simulation Content in a SCORM 2004 wrapper. Progeny will utilize an existing relationship with Rustici Software to aide with SCORM 2004 standard requirements. Rustici Software has worked with Progeny in the past to provide SCORM expertise. Rustici Software's SCORM Content Player is currently utilized by the Navy and Marines for rendering their SCORM courseware.

7.7.4 Deploy Prototype Leadership Assessment Center

Progeny will, with the help of the TPOC, establish a demonstration environment that showcases the Prototype Leadership Assessment Center integrated with AKO. This task will require considerable coordination between Progeny and various Army officials. At a minimum Progeny will deploy the Prototype Leadership Assessment Center using the applicable subsets of AKO or similar competing products. The intent is to demonstrate all of the discussed Leadership Assessment Center capabilities in an easily deployable environment.

7.8 Schedule



8 Related Work

8.1 Non-Tactical Data Processing System Software Integration

Naval Sea System Command - Contract No. N00024-98-C-6226

Progeny is responsible for the integration; testing and certification of the NTDPS software for delivery to the VIRGINIA program (Electric Boat for Contractor Furnished System) as well as to the back-fit fleet through NUWC Newport and PMW 165 for SubLAN installation on 688 class submarines. This effort pulls together numerous Government and commercial software applications into a coordinated product with functionality defined by the NTDPS "A" Specification that is agreed to by TYCOMS/SEA08. Progeny is responsible for configuration management, risk management, and delivery of the various software baselines. Tasking includes development of an end-to-end (ship-to-shore) solution leveraging the VIRGINIA class Non-Tactical Data Processing System Paperless Ship Applications, Submarine Non-Tactical Application Delivery Interface System (SNADIS), and TDKM products with delivery to SPAWAR PMW 165 and NUWC for certification and fielding to SSN 688 and VIRGINIA class submarines starting in Oct 2004. The effort also includes the development of a non-tactical point of delivery system required for enhancing the quality of work on board navy vessels by delivering just-in-time training and other learning products via the Integrated Shipboard Learning Environment (ISLE). This effort is being done in cooperation with the Submarine Learning Center (SLC) (establishing functional requirements) and uses the TDKM product for shore-to-ship content synchronization. Progeny has developed the concept of operations for the Submarine Learning Center TDKM wholesaler and Content Management Server and is working on the issue of shore-to-ship connectivity. This project contains identical functionality as being constructed on the shore-side infrastructure for the NAVSEA's Distance Support Initiative and the CNO's Revolution in Training.

8.2 Advanced Logistics Using Multimedia Technology

Naval Sea System Command - Contract No. N00024-03-C-4104 & N00024-04-C-4194

Under this Phase II Small Business Innovative Research (SBIR) contract, Progeny Systems will provide the capabilities of the Semantic Web to TD/KM. That is, provide a semi-structured information infrastructure by adding semantic context about the learning and/or technical content.

This effort addresses development of high-level requirements such that shipboard content management system functionality can be implemented using SCORM and S1000D for reuse of technical/learning content. This effort also addresses the development of system/software architecture for the contextualization, discovery and resolution of learning/technical objects. Progeny Systems in conjunction with the current TDKM program deriving a set of compatible metadata technologies that can be used for information metadata and information semantics, and their associated schema and predicate languages. This project also entails development of an Information Object Framework that permits disparate metadata technologies to interoperate thus enabling platform integration across providers and within affordable technology refresh cycles. This includes development of a semi-automated process to create information semantics using information metadata to accelerate initial development and to provide an infrastructure for collaboration.

This SBIR also includes identifying and relating the most relevant technologies and specifications that can be applied to TD/KM and Distance Support, in line with the developed architecture. As well as developing a set of prototype components that can demonstrate selected functionality from an end-to-end, i.e., shore based content-to-performance enhancement in the hands of the Sailor (Submarine Knowledge Management).

8.3 Hybrid Sailor Performance and Training

Progeny proposes to create a set of constructs necessary for the assessment and selection of Sailors for a new class of surface combatant: the Littoral Combat Ship (LCS). The LCS has a stated concept of operations to have a reduced crew complement while simultaneously having a larger than average mission profile. In order to meet this goal, the Navy awarded Progeny a Phase I contract to create a set of constructs that measure a Sailors ability to do multiple roles and be a "hybrid" of current roles and rates. In other words, the preferred sailor will not only be a skilled sonar operator, but also have aptitudes for troubleshooting, and have a high tolerance of ambiguity. The complete list of constructs is still underdevelopment, but once completed, Progeny will create a plan to conduct a Job Analysis necessary to validate its models and develop the knowledge, skills and abilities (KSA) used for testing "human attributes" that are not currently tested.

One construct that has been identified is that of "leadership." The research for the Army SBIR and for this Navy SBIR is synergistic and provides a mechanism for cross pollination between the two branches of the armed services.

9 Relationship with Future Research or Research and Development

Progeny Systems has several efforts that are related to the assessment of individuals on multidimensional constructs. One effort is with the Navy and entails the assessment and later the selection of Sailors who will perform "hybrid" tasking on the new surface combatant (the Littoral Combat Ship.) Additionally Progeny is working with different Navy and Marine Commands to work out the details and plans necessary for utilizing and integrating Progeny's Afloat Integrated Learning Environment with other tools and software like Question Mark (http://www.questionmark.com/us/home.htm) to provide additional assessment capabilities.

Outside of new capability development, Progeny intends to further mature the tools developed under this SBIR in order to meet emerging needs from existing customers.

Additionally, Progeny is investigation commercializing the concepts developed in this SBIR and other SBIRs to provide services to small and medium size businesses that can not afford the expensive assessment batteries offered by other companies.

10 Commercialization Strategy

Progeny Systems has a proven track record in transitioning Phase I SBIRs to Phase III commercialization. Between 1996 and 2004 Progeny Systems won 39 SBIRS, 27 have transitioned to Phase II and 6 of those are in Phase III. Progeny takes the approach of exploiting affordable, mature COTS and open standard technologies to provide both effective and cost-efficient solutions. This approach also leads to reliable systems with low life-cycle costs that also have efficient paths for future technology refresh without the restrictions of vendor-lock and proprietary designs. Progeny Systems competencies include Research and Development, Systems Integration, and Product Development and Manufacturing. This unique mix of capabilities gives us a competitive advantage among small businesses allowing us to be effective throughout the entire technology development process to best meet our customer needs.

10.1 Market Need

At the present time there is no objective means to assess the leadership skill levels of military officers. This has lead to complaints by large numbers of officers who have identified the lack of objective assessment as a serious issue, which results in decreases in motivation. The developmental feedback provided to them by superiors which subordinates use to chart career development has also been limited due to the recent operational tempo of the military services. Additionally, research has shown that in some case feedback by human supervisors is not as effective as feedback provided by software because users feel that software is less biased or motivated by external forces. By having software which is capable of providing on demand unbiased skill assessment and corresponding exercises, officers would be self-aware of their skill levels and more motivated to perform their jobs. Further, the assessment data could be used by an automated development center, which could chart/schedule training courses and or indicate that the individual was deserving/prepared for advancement/promotion. This would lead to an increase in personnel moral and happiness, which in turn will lead to, improved performance. Not to mention that the exercises will continually increase skill levels.

There is little disagreement among military, industry and academia that ADL improves costs and efficiencies by distributing inexpensive instructional components to physically remote locations and the simulation of expensive devices for both operator and maintenance training. The optimal solution is to provide a collaborative environment accessible from the computer devices we use every day. To provide the best accessibility, ubiquitous infrastructures such as the Internet, Web and communications must be used. We anticipate many opportunities for Phase II prototypes across DoD, Federal, and civilian organizations that will position us for a Phase III transitional program.

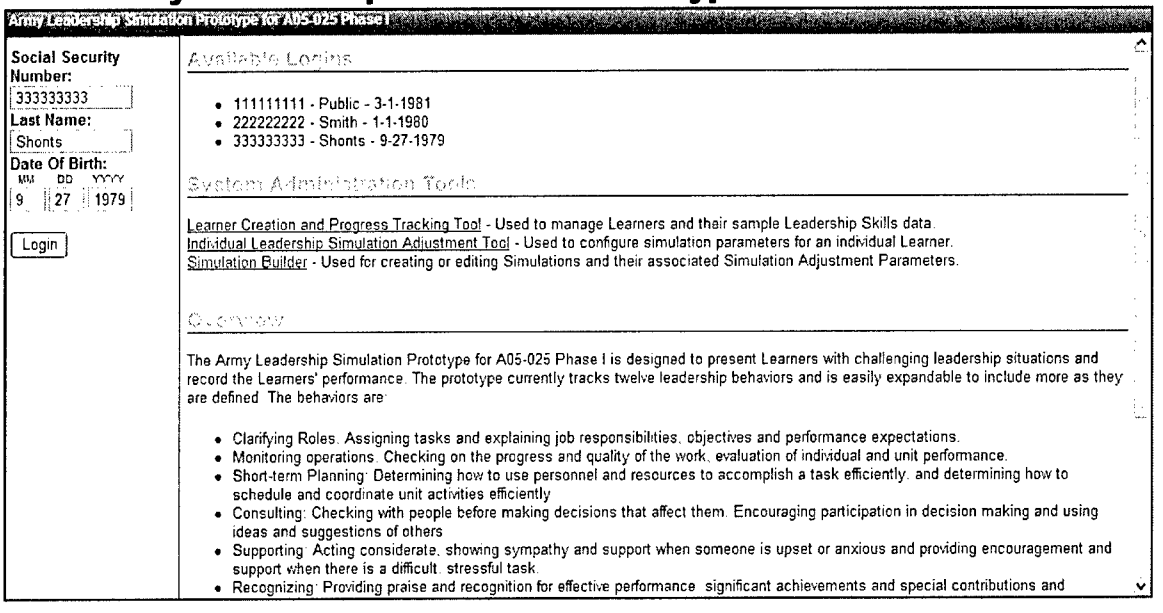
We intend to commercialize these components into our Integrated Learning Environment for the NAVY, ShipMATES, Minimum Bandwidth Distributed Simulations for Warfighter Shipboard Training programs, and other emerging worldwide, network-based, information management applications. Our experience has shown that migrating SBIR developed products into our existing military programs has proven to be beneficial to both the agency responsible for the research and the agency receiving the developed product.

10.2 Non-DoD Market Need

Although there are many commercial assessment centers in existence, the fees for enrolling personnel in the centers are quite large and cost prohibitive to many small to medium companies. By developing software, which is capable of providing similar assessment performance as the centers, the staff of small to medium size companies would now have the opportunity to conduct in depth skill assessments to identify areas that need development. Further the exercises in the software would provide the continual means by which employees could improve their skills at any time. Improving the skills of managers will translate into higher productivity and reduced costs for companies. In addition, by improving tacit or interpersonal skills, conflicts between employees should decrease and the motivation of employees' increase, which again will translate into, increased company productivity.

11 Appendix A: A05-025 Simulation Prototype Walkthrough

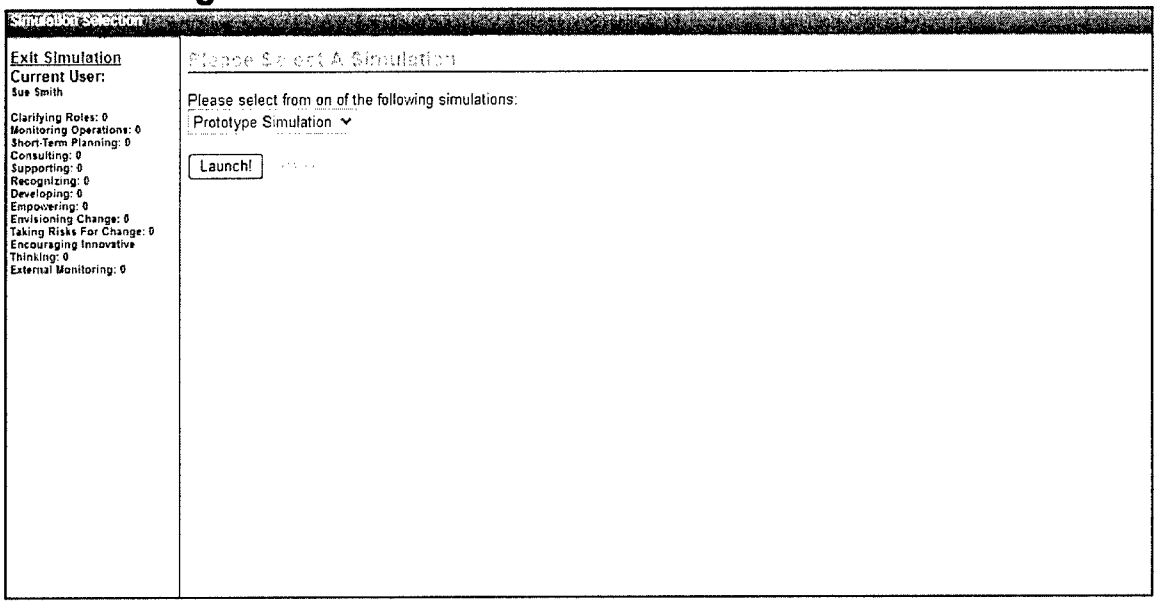
11.1 Army Leadership Simulation Prototype



114-1 ALS Welcome and Login Screen

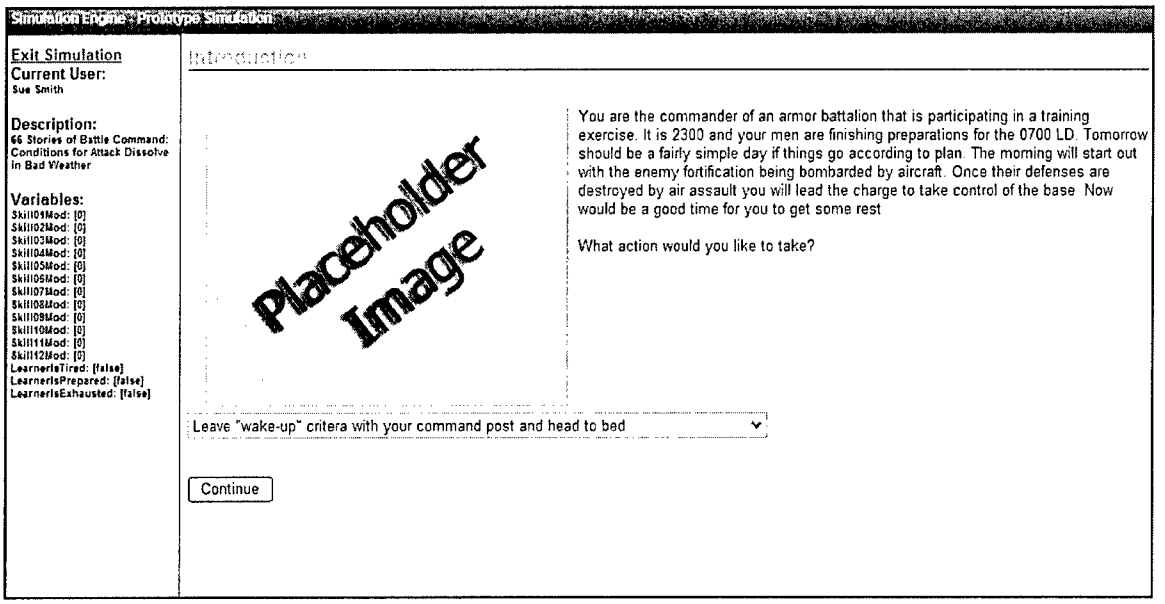
The Army Leadership Simulation Prototype (ALS) is composed of a simplistic Learner Management System (LMS), a simplistic Learning Content Management System (LCMS) and a reference Simulation Engine. Once a Simulation has been developed using the Simulation Builder it is registered in the ALS LCMS and made available to all Learners. The ALS LMS Main Welcome Screen is shown in Figure 114-1.

11.2 Taking the Simulation



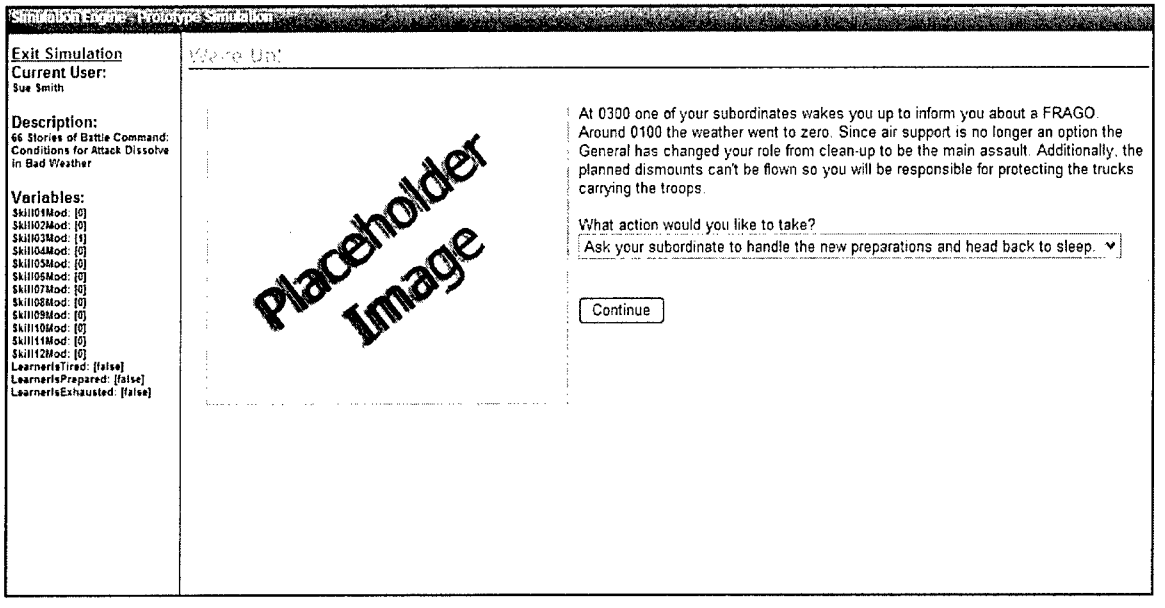
114-2 Simulation Selection Screen

After successfully logging in to the ALS LMS the Learner is presented with the Simulation Selection Screen (Figure 114-2). The drop down list contains all of the Simulations that have been registered with the LCMS. If the Learner has previously completed the selected Simulation the Review button becomes enabled. In the left hand column the Learner's cumulative Leadership Behavior scores are shown.



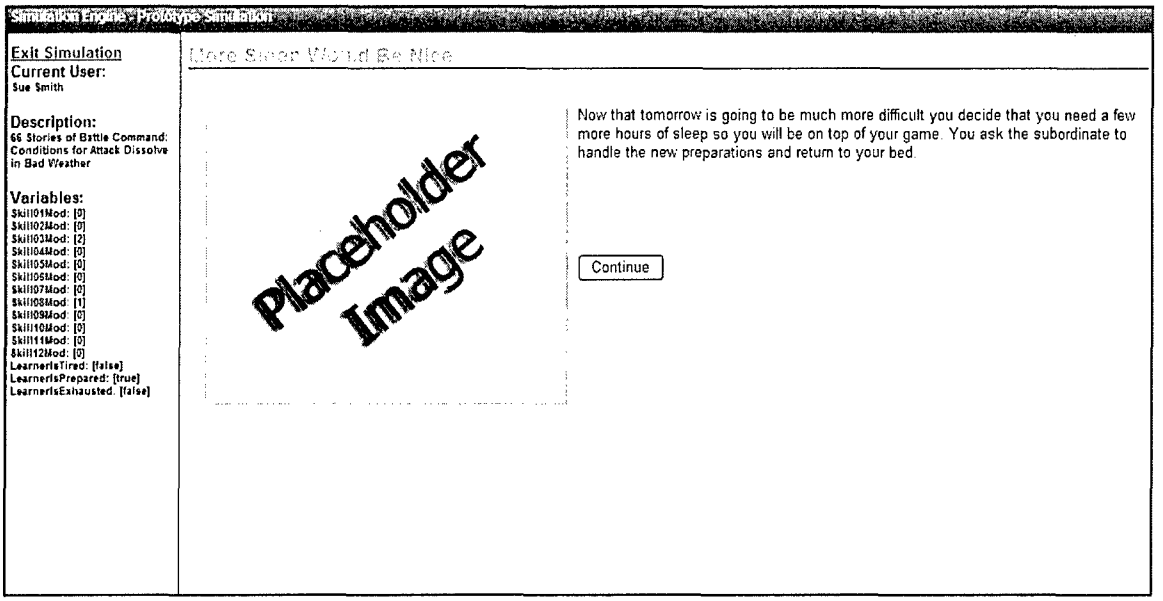
114-3 First Decision Node

Once the Simulation is launched the left column contents are replaced with the Simulation Description and the current values of the simulation variables. This display is used for Simulation debugging purposes. In the right column the contents of the Decision Node are displayed. These usually consist of a Page Title, Story Text, Story Image or Media, Question and possible Decisions. The Learner selects the appropriate response from the drop down and clicks "Continue".



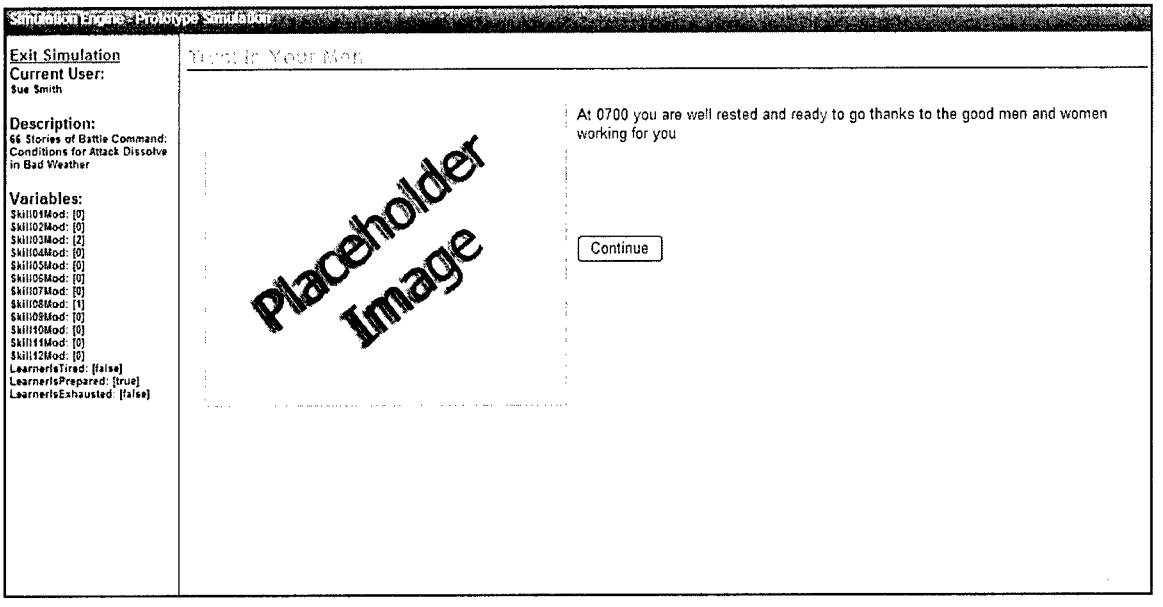
114-4 Second Decision Node

Simulation variables are modified when the Learner makes a decision. In this screen Skill03Mod has been changed from 0 to 1. This indicates that the Learner's choice has increased their Short-Term Planning Leadership Behavior. After the variables are processed the Simulation Engine presents the appropriate destination node defined by the decision the Learner made. While this demonstration only shows one possible path, each decision made by the Learner impacts their path through the Simulation.



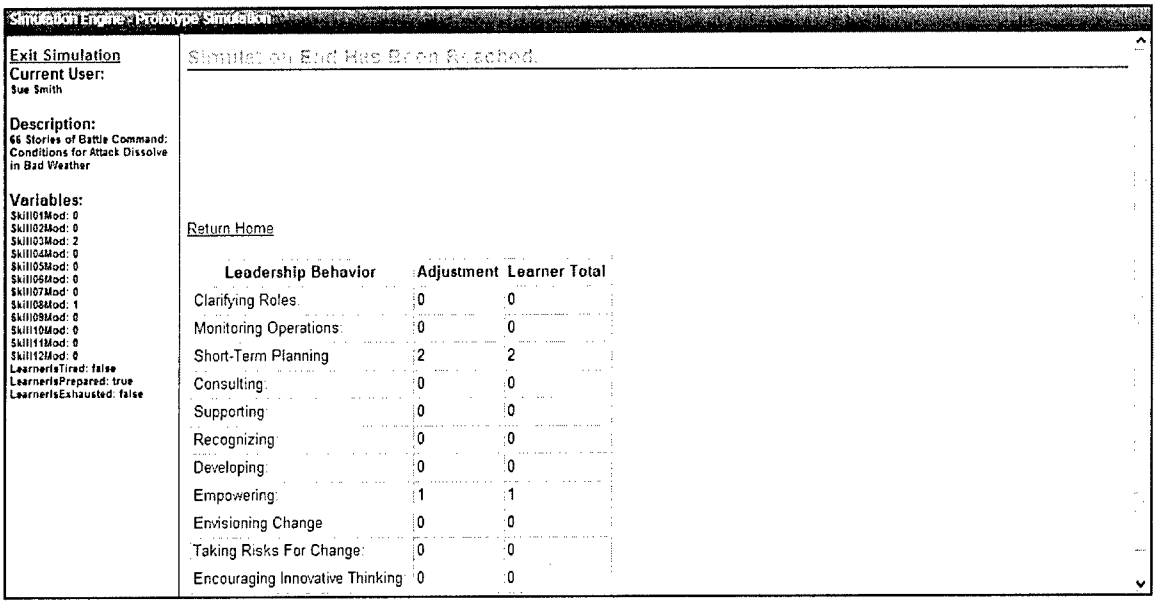
114-5 Story Progression Node

Not all nodes require input from the Learner. In some cases it is beneficial to break up the Simulation story into smaller chunks. This is handled by the "Continue To" node. These nodes simply present the story content and a button that linearly progresses to the next node.



114-6 Second Story Progression Node

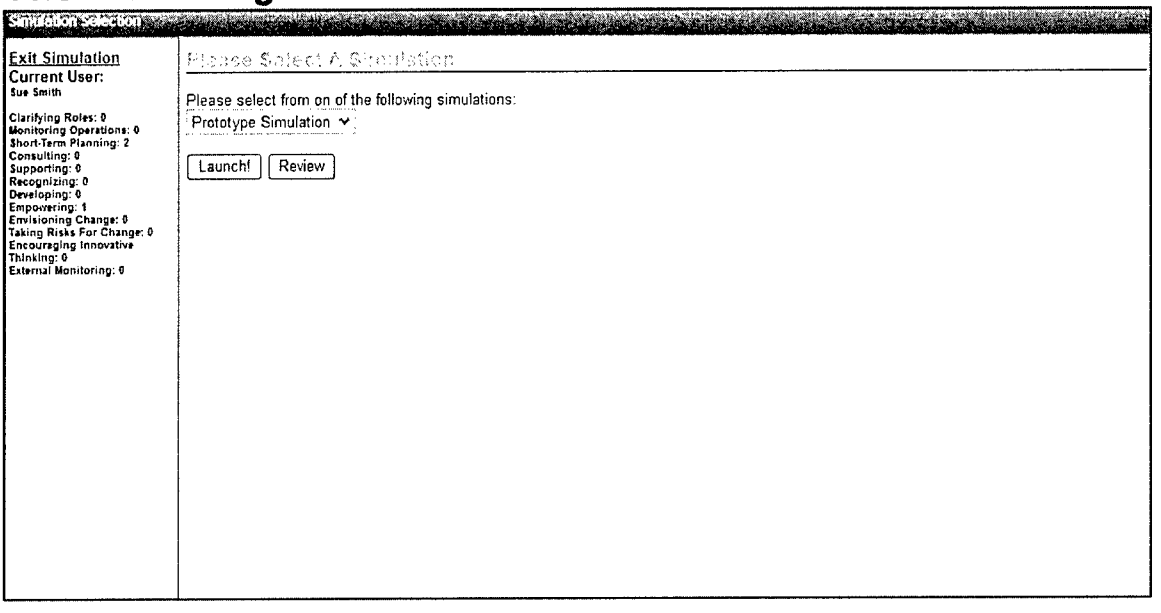
Figure 114-6 is another "Continue To" node.



114-7 Simulation End with Performance Report

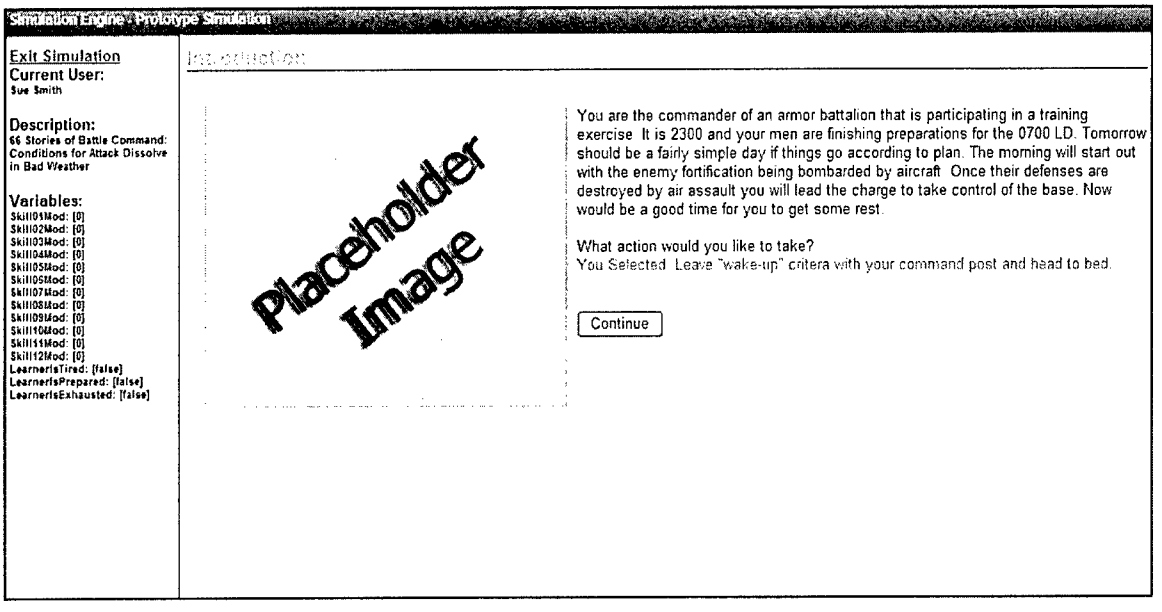
Once the Simulation End has been reached the Learner is presented with a score card that shows their Leadership Behavior adjustments from their simulation attempt along side their cumulative Leadership Behavior Scores.

11.3 Reviewing Your Performance



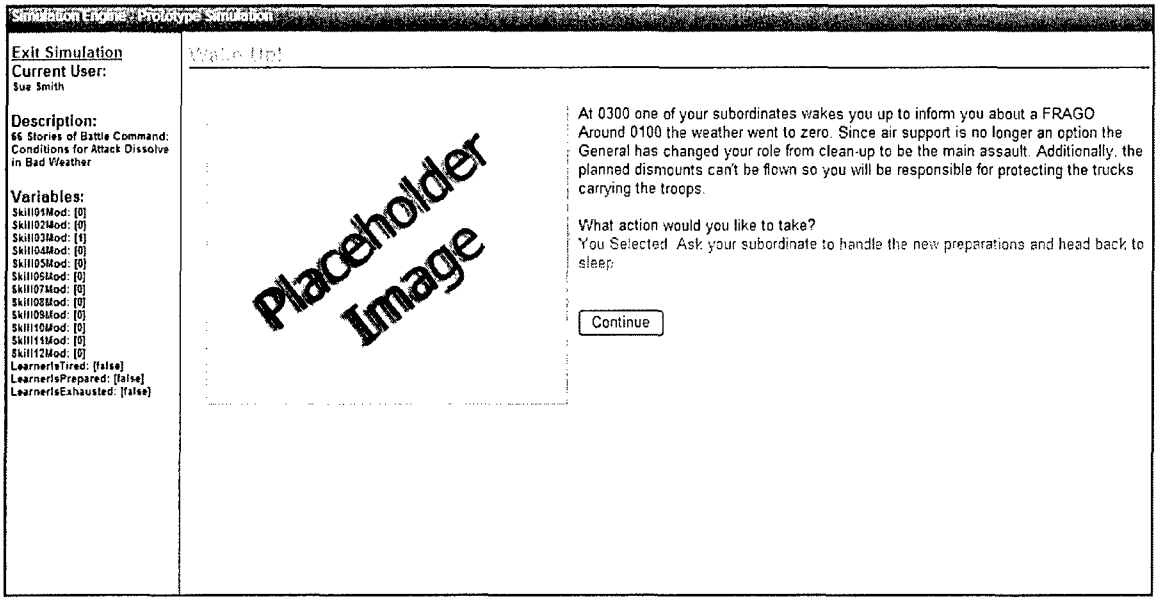
114-8 Simulation Selection Screen (Review Enabled)

The next time the Learner selects the Simulation the Review button is enabled. Reviewing the Simulation lets the Learner walk through their previous actions within a given simulation.

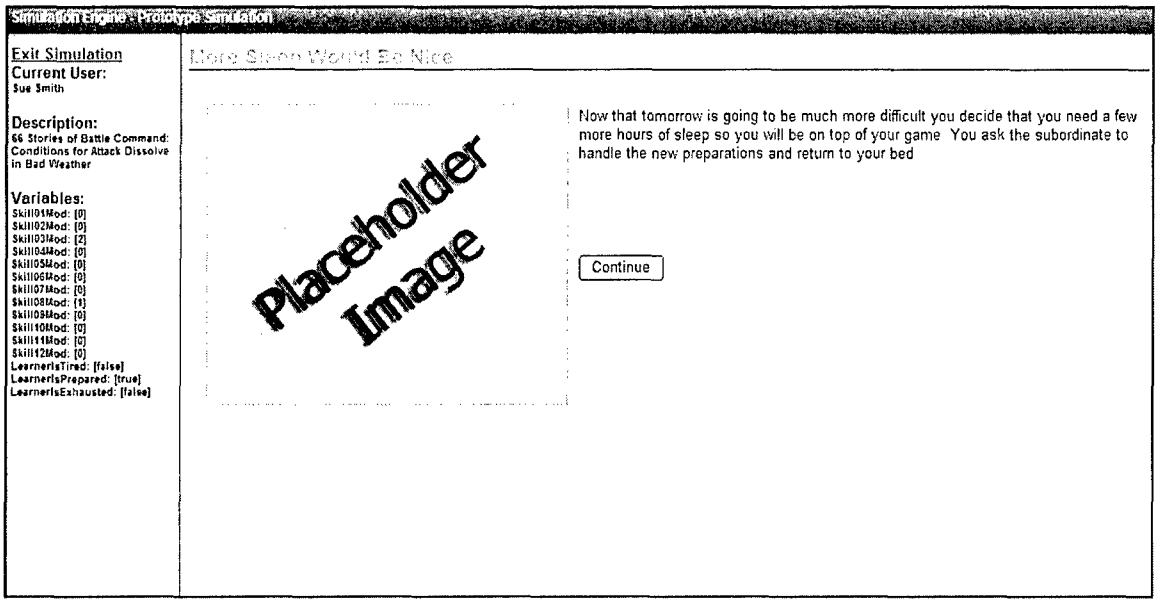


114-9 First Decision Node with Your Selection

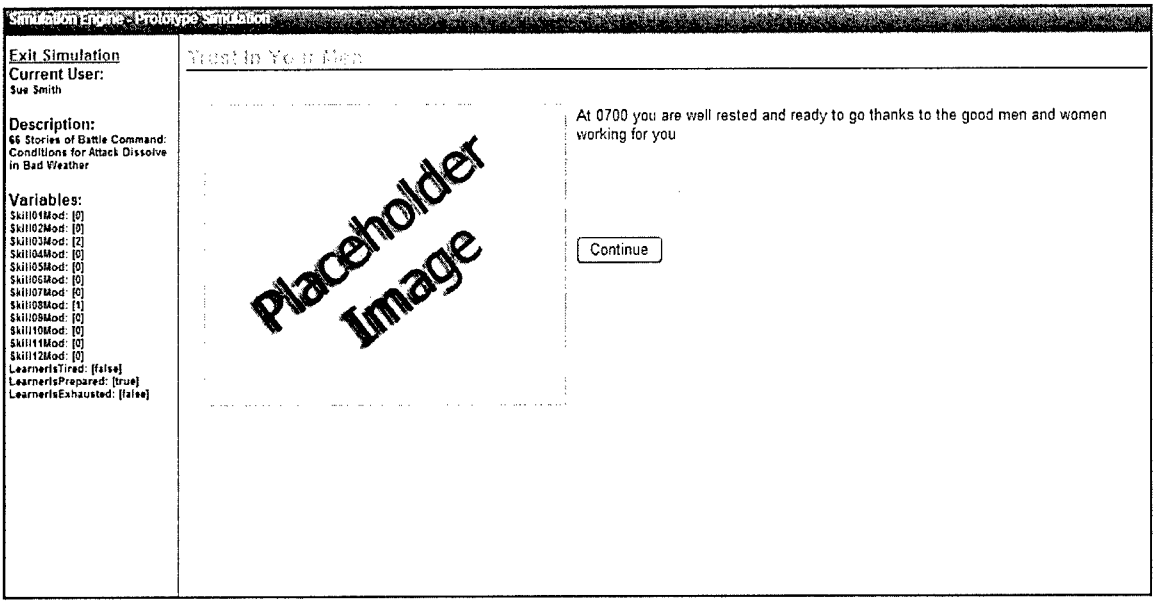
Instead of being allowed to make the decisions the Learner is shown what decision they made.



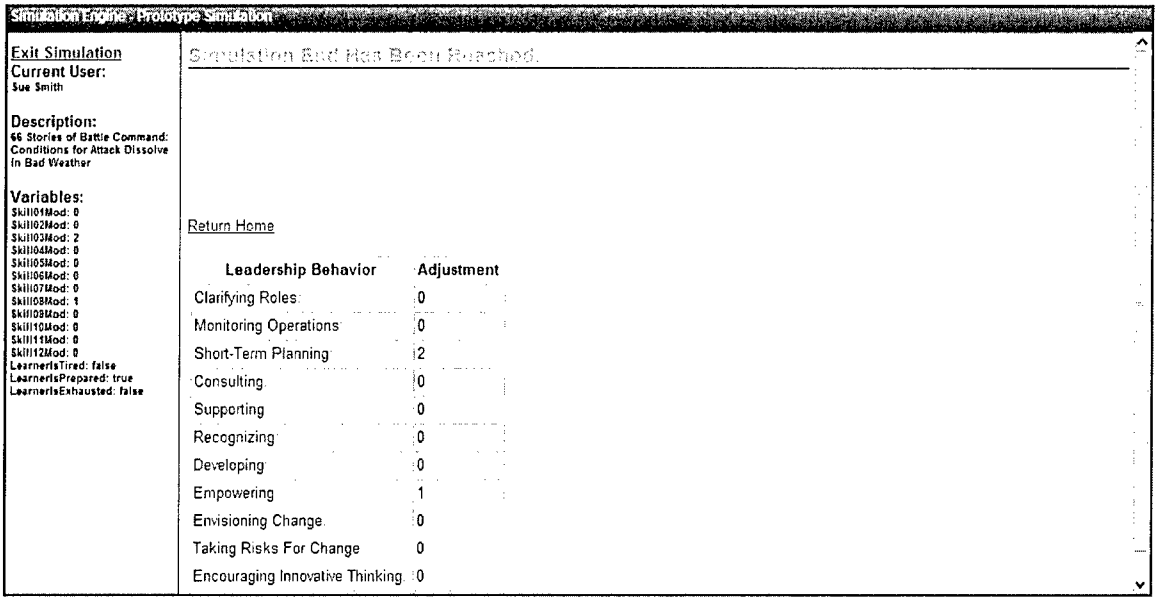
114-10 Second Decision Node with Your Selection



114-11 Story Progression Node



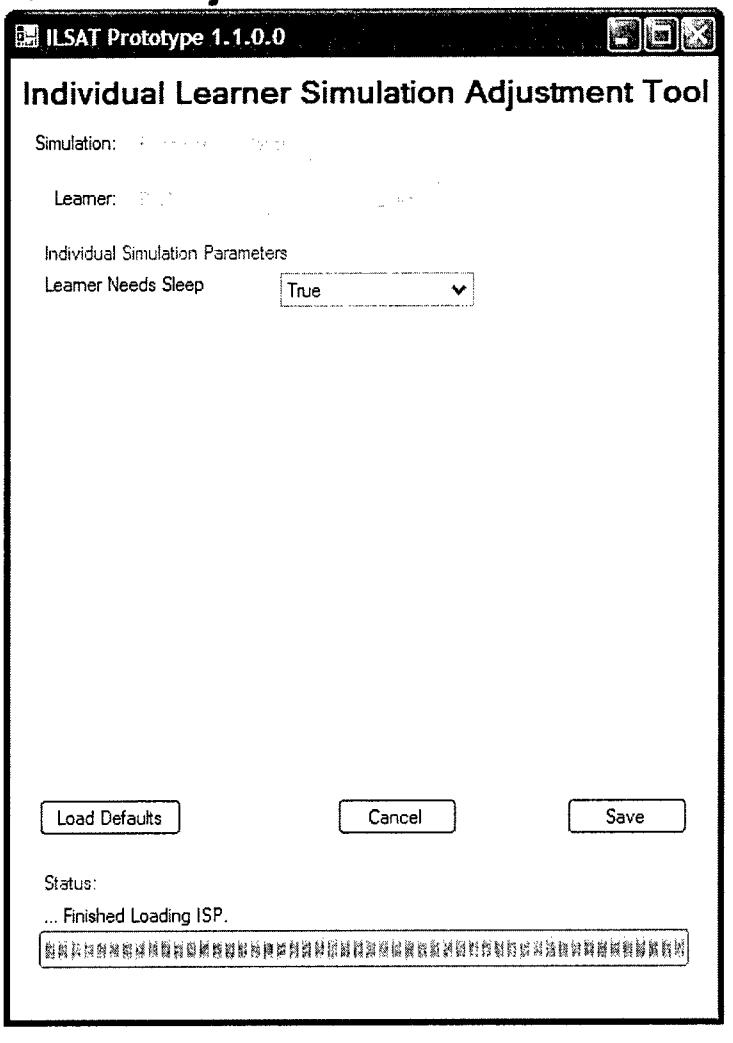
114-12 Second Story Progression Node



114-13 Review End with Recorded Simulation Score

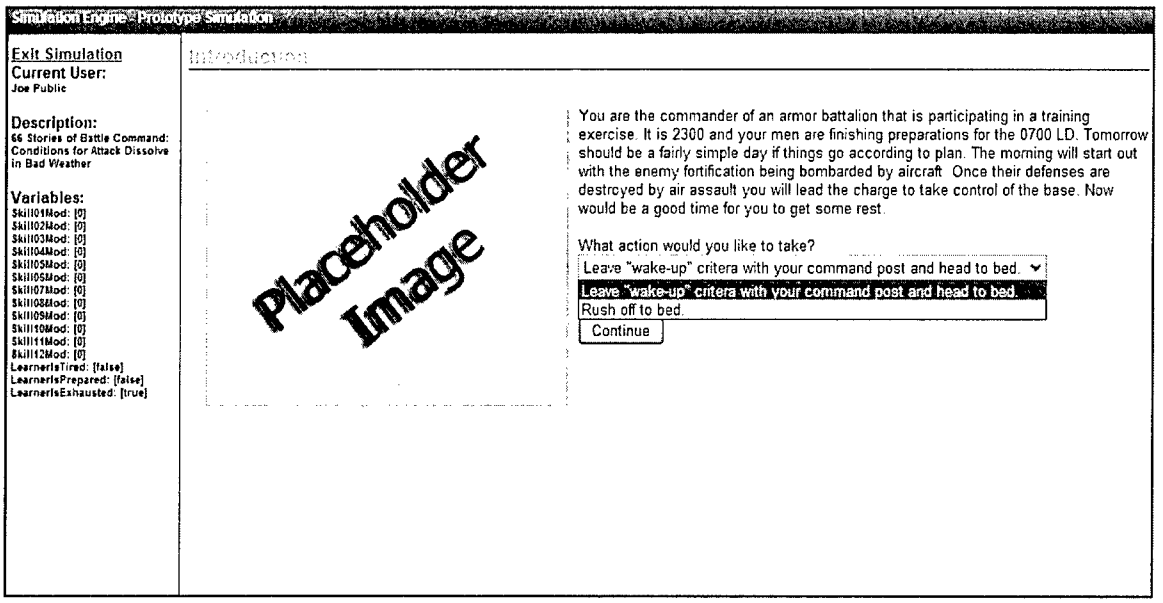
At the end of a Review the learner is presented with the saved score card. Unlike the score card at the end of taking a simulation, the review mode just shows the Leadership Behavior score adjustments achieved from the reviewed simulation attempt.

11.4 Effect of Individual Adjustment Parameters



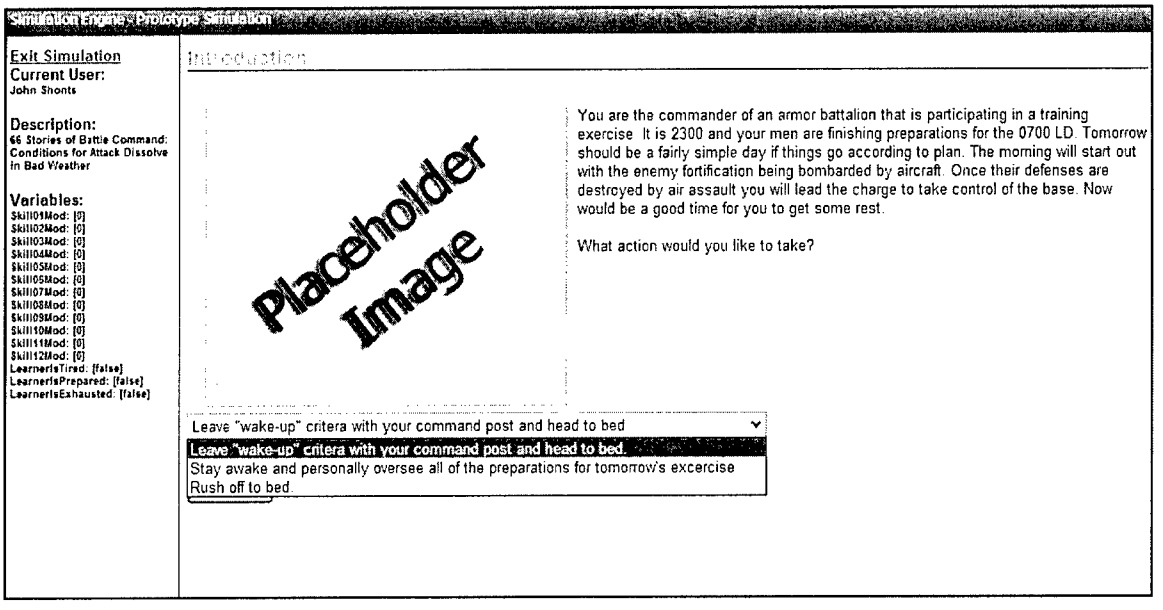
114-14 ILSAT Tool Modifying the "Needs Sleep" Setting

The Simulation Engine has a method for allowing Training Administrators to adjust settings for individual Learners. The available settings are determined by the Simulation authors. Figure 114-14 shows the Training Administrator setting the "Needs Sleep" parameter to "true".



114-15 Learner with Limited Options

The Learner taking the Simulation in Figure 114-15 is limited to two options.



114-16 Learner with all available options

The Learner taking the Simulation in Figure 114-16 has all three options available.

12 Appendix B: Evaluation Metrics for Gaming Engines

The selected engines were evaluated based on their ability to provide the following functionality:

- Ability to deliver compelling visual representations of simulation objects
- Ability to deliver audio to support the simulation
- Ability to be deployed over the web
- Ability to script actions and objects within the simulation environment
- The functionality measurements have been defined as **Excellent, Good, Poor** and **None.**
- Additionally, the engines were evaluated on the following criteria:
- Initial Cost
- Licensing Terms
- Target System Requirements (Hardware and Software) in terms of Cost
- Ease of Development in terms of Cost
- Ease of Maintenance in terms of Cost

The cost measurements have been defined as **Expensive, Affordable, Cheap,** and **Free.**

Licensing Terms have been defined as Difficult to Comply, Simple to Comply, or No Compliance Required. These are marked in the Evaluation Matrix as **Difficult, Simple** and **None** respectively.

Since Ease of Development and Maintenance vary depending on the developer's skill the evaluation assumes that the developer has no knowledge of the specific programming language or engine. Therefore, "ease" is based on the relative learning curve for each development environment.

12.1 Evaluated Engines

The following engines were evaluated using the above Evaluation Metrics to determine which engine would be most suitable for developing the prototype required by the SBIR. Progeny's end goal is to provide interfaces to the prescriptive learning and simulation control components that will work in almost any engine. For the purpose of this evaluation it is important to note that ES3 and Unreal have an "unfair" advantage over the other engines due to their existing use by the Army. This evaluation has attempted to not include any benefits provided by this existing use. However, these benefits are worth looking into for work beyond the Phase I prototype.

		Functionality				Costs				
		Visual Appearance	Audio Support	Scripting Support	Web Deployment	Initial Cost	System Reqs.	Development	Maintenance	License Terms
Evaluated Engines	Cube	Good	Good	Good	Good	Free	Affordable	Cheap	Cheap	Simple
	Ogre3d	Excellent	None	None	None	Free	Affordable	Expensive	Expensive	Simple
	LJGL	Good	Good	None	None	Free	Affordable	Expensive	Expensive	Simple
	Source	Excellent	Excellent	Excellent	Poor	Expensive	Expensive	Expensive	Expensive	None
	Unreal (PC)	Excellent	Excellent	Excellent	Poor	Expensive	Expensive	Expensive	Expensive	None
	Unreal (Xbox)	Excellent	Excellent	Excellent	None	Expensive	Affordable	Expensive	Expensive	Difficult
	ES3	Poor	Good	None	Good	Free	Affordable	Cheap	Cheap	None
	Flash	Good	Good	Good	Excellent	Affordable	Cheap	Affordable	Affordable	None
	FPS Creator	Good	Good	Excellent	Good	Affordable	Affordable	Cheap	Cheap	None

Figure 7 Evaluation Matrix

12.2 Cube

Vendor: Open Source (creator: Wouter van Oortmerssen)

License: ZLIB

Cost: Free

URL: http://www.cubeengine.com/

12.2.1Strengths

In-engine editing environment

Easy to develop simple environments

Contains existing assets

Community support with available free assets

12.2.2Weaknesses

Visuals are sub standard

Environments lack any curvature and end up looking very blocky this severely detracts from the experience

Included assets don't apply to this effort

12.2.3Summary

The Cube engine is an Open Source First Person Shooter creation tool. It's most innovative feature is the in-engine editor. This editor allows the simulation developer to virtually walk around the environment and add objects to their current location. Cube also has a decent community following that provides assets and support to other developers. The ease of use provided by this engine is counter balanced by the limited geometry support within the environment. No matter how detailed the environment textures, simulations always appear to take place in a 3D version of Tetris.

The successor to Cube, Sauerbraten (http://strlen.com/sauerbraten/index.html) appears to have overcome the geometry limitations. At the time of the evaluation this engine is not fully functional. In the effort beyond Phase I this engine should be re-examined.

12.3 Ogre3d

Vendor: Open Source

License: LGPL

Cost: Free

URL: http://www.ogre3d.org

12.3.1Strengths

Provides easy access to powerful 3D rendering technologies.

12.3.2Weaknesses

Just a 3D rendering library not a full game / simulation engine.

Requires C++ development skills.

12.3.3Summary

Ogre3D is a very powerful and well documented 3D rendering library. It has been used by several projects to handle the visual processing for various games and other non-game related applications. While it can be utilized to provide very vivid and rich 3D visuals to a simulation it doesn't bring the full package. Libraries for AI, sound, control, scripting and networking would all need to be sourced or developed. If Progeny intended to develop a custom 3D simulation environment Ogre3D would likely be used to abstract the visual component.

12.4 Lightweight Java Gaming Library

Vendor: Open Source

License: BSD

Cost: Free

URL: http://lwjgl.org

12.4.1Strengths

Utilizes Java which enables it to easily run on multiple target environments with little to no modification.

Easily exposes Graphics, Audio and Control components to the Java developer.

12.4.2Weaknesses

Not a full game / simulation engine.

Requires Java development skills.

12.4.3Summary

The Lightweight Java Gaming Library (LJGL) is a set of APIs that allow the Java developer to utilize OpenGL, OpenAL and various Game Pads and other input devices while developing simulations or games. While the LJGL provides more components than Ogre3D it is simply a library to aid in simulation / game development. A skilled Java developer is still required to implement AI, networking and scripting elements.

12.5 Source

Vendor: Valve

License: Proprietary

Cost: Disclosed under NDA

URL: http://www.valvesoftware.com/business.html

12.5.1Strengths

Powerful graphics engine that supports DirectX6 through DirectX9 hardware

Powerful scripting engine

Powerful AI engine

Powerful Physics engine

Vehicle support

Large community support

12.5.2Weaknesses

Expensive

Developers must be familiar with using the provided development tools

Not designed for rapid simulation development

Due to high quality assets final package size is large making web deployment an issue

12.5.3Summary

The Source engine is the same engine that powers Half-Life 2 and Counter Strike: Source. These are two of the most popular games played online. Due to it's popularity every feature of the engine has been extensively tested by the developers and the players. Many third party "Mod" makers have developed assets that can be utilized by the Source engine. Some of these assets pertain to the SBIR effort (weapons, vehicles etc) and can be utilized for free. The AI and scripting abilities are phenomenal and compare to the Unreal engines capabilities. The Source engine's realistic physics and character animation features go a long way in creating life like environments. With all of these features comes a hefty price both in upfront cost and in development time. Simulations developed using the Source engine are likely to take many months to a few years each to complete. Another issue is the file size of a completed simulation. By utilizing high quality models and textures the simulation would be difficult to deploy over the web.

12.6 Unreal 2 (PC)

Vendor: Epic Games

License: Proprietary

Cost: Disclosed under NDA

URL: http://www.unrealtechnology.com

12.6.1Strengths

Powerful graphics engine

Powerful scripting engine

Powerful AI engine

Powerful Physics engine

Vehicle support

Large community support

Currently Used by Army for the America's Army simulation

12.6.2Weaknesses

Expensive

Developers must be familiar with using the provided development tools

Not designed for rapid simulation development

Due to high quality assets final package size is large making web deployment an issue

12.6.3Summary

The Unreal 2 engine has been used in many award winning games. It has incredibly powerful features and a large community of "Mod" creators. Some assets in the "Mod" community can be used by this SBIR at no cost. The US Army is already using the Unreal 2 Engine for the America's Army simulation (http://www.americasarmy.com) which contains Army approved assets. These assets may be usable by this SBIR effort. Like the Source engine, all the power provided by the Unreal engine comes at a great price. While the upfront cost is not disclosed the Unreal 2 (Xbox)

pricing should provide a hint. Epic Games also has non-traditional licensing that they can offer which America's Army utilized. Further research may reveal that the Unreal Engine could be very affordable. The other major drawback is the resulting simulation file size. The large size will make web based deployment difficult.

12.7 Unreal 2 (Xbox)

Vendor: Epic Games

License: Proprietary

Cost: $350,000 + 3% of revenue from game

URL: http://www.unrealtechnology.com

12.7.1 Strengths

Powerful graphics engine that supports DirectX6 through DirectX9 hardware

Powerful scripting engine

Powerful AI engine

Powerful Physics engine

Vehicle support

Inexpensive deployment platform

12.7.2 Weaknesses

Expensive software

Xbox development hardware is expensive

Non-web deployable

Difficult to update even using Xbox Live!

Difficult to import skill sets

Difficult to export learner progress

12.7.3 Summary

After meeting with ICT and learning about the success of Full Spectrum Warrior and their reasoning for choosing the Xbox as a deployment platform, Progeny decided to investigate the technologies that ICT used. It became immediately apparent that this technology would not meet our needs due to the deployment platform's limitation with exporting learner progress. While the Xbox provides a very stable and affordable deployment platform it is far too expensive and difficult to develop simulations for.

12.8 Every Soldier a Sensor Simulation

Vendor: US Army & ICT

License: N/A

Cost: Already Owned By Army

URL: https://slimes3.rdecom.army (Requires AKO account)

12.8.1 Strengths

Easily deployable

Can easily add assets to the simulation

Can easily create new simulations with the built-in editor

Designed with Army training in mind

Is a complete simulation development package

Coding is not required

12.8.2Weaknesses

Poor visuals

Most assets are 2D bitmaps which always face the user in the 3D environment

Limited built-in maps

Not Scriptable

12.8.3Summary

Every Soldier a Sensor Simulation (ES3) is a training tool developed by the ICT and is currently in use by the Army. It was developed specifically for Army training, easy web deployment, and easy simulation creation. Adding new assets to the simulation development tool is trivial and can be done using slightly modified digital camera images. This allows content creators to simply take a photo of an object, scale it down and remove the background then import it into the simulation. Content creators could develop situationally pertinent training while deployed in the field. Since ES3 was designed with a specific Army training methodology in mind it does not support the level of scripting that is required for this SBIR. Progeny will need to work with ICT to add this functionality. Additionally, a process for easily adding new maps would need to be developed.

12.9 Flash Professional

Vendor: Macromedia

License: None

Cost: $699

URL: http://www.macromedia.com/software/flash/flashpro

12.9.1Strengths

Powerful rendering engine

Powerful scripting engine

Powerful animation tools

Extensive community support

Large number of free assets

Small resulting file sizes

Easily deployed

Runs on multiple platforms and devices

Can utilize a variety of media formats including MP3, QuickTime Movies and Digital Images

12.9.2Weaknesses

Not specifically a simulation engine

Not specifically a 3D engine

Requires Flash development skills

12.9.3Summary

Macromedia Flash is practically a ubiquitous standard for deploying rich media on the web. The Flash player has been included as part of the Microsoft Windows install and is standard on almost all PCs. The Flash player is supported on all popular operating systems and many mobile devices such as Phones and PDAs. Simple Flash development is easy and compelling "movies" can be created in a short amount of time. Advanced Flash development simply combines the "movies" with some Action Script. The Advanced development is more rapid than other environments such as Source and Unreal. Even though Flash isn't designed specifically for creating simulations a reusable simulation engine can be easily developed. Progeny would develop this simulation engine for the SBIR prototype. One of the pivotal features is Flash's web deployment capability. The technology was designed specifically for delivering rich content over the web. The small SWF files generated by the Flash development environment are directly supported by popular Learning Content Management Systems (LCMS) such as OutStart's Evolution.

12.10FPS Creator

Vendor: The Game Creators

License: No Royalty

Cost: $50.00

URL: http://www.fpscreator.com

12.10.1Strengths

Rapid Development (a simple game using default models and objects can be made in as little as 15 minutes)

Low Cost

Included assets with a user community that has developed more free assets

Engine, assets and resulting works are all royalty free. Games created can be given away or sold with no obligation to compensate the vendor beyond the original purchase price.

The engine source code is available for modification.

Source code does not need to be released even if the engine is modified.

Competent default AI with full waypoint and scripting support.

12.10.2Weaknesses

Default assets are WW2 and Sci-Fi which don't apply to this effort.

Engine is "indoor" which prevents expansive terrain development seen in Unreal or Source

12.10.3Summary

FPS Creator is First Person Shooter rapid development tool. It contains an intuitive editor, pre-built room models and a long list of other assets. Using the included assets a fully functional game can be created in minutes. The Engine, Models and other assets are all royalty free and can be sold or given away with no mention of FPS Creator or The Game Creators included.

12.11Results of Simulation research

The results for the Phase I prototype effort pointed to the use of Macromedia Flash. While not as easy to develop simulations with initially as some of the other engines Progeny intended to release the code that powers the prototype simulation. This code can be utilized by future simulations to

reduce development time. The primary reason why Progeny chose to utilize Flash for the Phase I prototype is its ability to be deployed over the web. Progeny will not have to develop extensive code to deliver Flash simulations through existing LCMS software such as OutStart's Evolution. This will greatly reduce the work needed to build an effective training simulation prototype. Since the gaming development aspect of the phase I effort was deprecated, the analysis as to the preferred gaming engine will be revisited if Progeny is awarded a Phase II.